SCIENTIFIC AMERICAN SUPPLEMENT

VOLUME LXXXVII
NUMBER 2250

★ NEW YORK, FEBRUARY 15, 1919 ★

Published weekly. Entered as second class matter, December 15, 1887, at the Post Office at New York, N. Y., under Act of March 3, 1879

10 CENTS A COPY
$5.00 A YEAR

One of the present-day inhabitants of the ancient canyon at her out-door loom

CANYON DE CHELLY OF ARIZONA [See page 100]

The Islands of the Pacific*

Their Present State and Future Importance

By Sir Everard im Thurn, K.C.M.G., K.B.E., C.B., LL.D.

It seemed to me that at the present great moment in the history of the world a statement by an eye-witness and student of the "present state of the Pacific Islands," and of how they came into that state, might be useful. I do not propose to touch on the surrounding land areas, except in as far as the story of these areas has a bearing on the condition into which "the Islands" had passed at the outbreak of the great war. I want it to be clearly understood that my strictly limited purpose is to draw a picture (it must be a mere sketch) of these remote and mostly small islands, which must shortly receive a small but not unimportant share of attention in the resettlement.

A glance at a specially drawn map of the Pacific Ocean shows it as a vast sheet of water stretching from the Arctic to the Antarctic lands, and almost enclosed, on the east by the whole western shore of America, from Cape Horn to Alaska, on the west (only interrupted by the narrow Behring's Strait) by the eastern shore of the Asiatic-Australasian land mass, from Siberia to New Zealand.

Within the water space thus enclosed lie the innumerable islands with which we are now concerned. With very few exceptions (and none of these here concern us except, perhaps, the Galapagos) the islands are gathered in one great group, most thickly along the east shore of Australia and thence along the equator, tapering to a point towards the American shore. They are, as it were, stepping-stones across from shore to shore, which have been used in the migrations of primitive folk, and are still of great importance as halting places in the passage from shore to shore.

It is of this great group of tropical islands—"the Western Pacific Islands"—that I shall mainly speak this afternoon, for the Hawaiian Islands, though somewhat isolated from the rest, may be considered as yet belonging to the group. Then it may be said that the only other islands of importance in the coming resettlement of the Pacific are the Galapagos (Chilian), which derive importance from the fact that they guard the western end of the Panama Canal.

The next point which it is important to note is that the islands, always excepting New Caledonia, are for the most part individually small—the greater number, indeed, mere specks, but in many cases (*e. g.*, the Solomon Islands, New Hebrides, the Fijis, and others) are so grouped as to give each set of islands almost the value of one large island.

Moreover, in this "Oceania" a mere statement of the length and breadth of an island as shown on a chart may give little idea of its land surface. For instance, in the "Low Archipelago," in the Eastern Pacific, the separate islands, some of considerable extent, are atolls, which, like countless others throughout this ocean, are mere rings of coral rock rising from the bottom of the ocean. In such cases the whole centre of the island is occupied by a lagoon, valueless to its inhabitants, unless its waters contain pearl shell, and only this surrounding rim of rock, often almost bare of soil, affords foothold for land plants.

Again, islands which occupy very little space on the sea surface may be of great value either for economic or strategic purposes. For instance, of the first kind, are Ocean and Pleasant Islands, both of which are solid masses of phosphate rock, and of the second kind is Fanning Island, which, though small in area—and most of that is taken up by its lagoon—is so situated as to be of great importance as a cable station.

There are other reasons which make some islands more desirable than others irrespective of actual size or extent of productive land surface. For instance, the little island of Pago-Pago (in the south of the Samoan group) is of great importance on account of its magnificent harbor. In short, a mere study of the map gives little idea of the comparative value of the islands.

What were the chief natural products of the islands before the intervention of Europeans? The most obvious was the coconut palm, which even then crowned every ledge of rock near sea-level, and had, though more sparingly, spread upward into the miscellaneous plant growth which clothed the slopes of the high islands. It is still a moot point where this palm originated; it was most probably in South America, whence it drifted in past ages across the Pacific. The coconut palm, which must always have supplied most of the chief needs of the original islanders, is, as far as I know, the only—or, at any rate, the chief—indigenous plant which has since become of very great economic value to Europeans.

Who were the "Natives" who were found in occupation of the islands when first visited by Europeans? That is a contentious matter, as to which it can here only be said that they were mainly of two types—Melanesian and Polynesian—distinguishable from each other, but yet sharing characters which distinguished them from the folk of other parts of the world. The chief point here to be noticed is that these islanders ("savages," the earliest European visitors miscalled them) had in their isolated island homes evolved for themselves a very considerable "culture" in arts and in social institutions, very different from, and, of course, much less advanced than, the so-called "civilisation" of the world outside our ocean, but yet, in its way, much more advanced than the "culture" to which the "savages" of many other parts of the world had attained.

This indigenous culture of the Pacific Islanders is of importance in the matter now under consideration. The islands being so scattered and isolated it was natural that this culture should have developed in different degrees in different parts of the Pacific. For example, the Melanesian of the Solomon Islands—at first sight a mere naked savage—had developed artistic instincts of a high if special order, in the making, and especially in the ornamentation, of his weapons, and had evolved for himself an elaborate and, in a way, serviceable set of social institutions. Further to the eastward, say in the Friendly Islands, the more stately and—at least on ceremonial occasions—tapa-clothed Polynesians had advanced along not altogether dissimilar lines, but to a much higher stage, both in artistry and in social institutions. Both had attained to a very remarkable degree of primitive "culture"—the Polynesian to a much higher degree than the Melanesian—but both lacked the one thing needful to give them "civilisation" as well as culture.

They lacked, *i. e.*, the one idea which is the foundation of civilisation as distinguished from mere culture —the idea and recognition of the dignity and rights of humanity. They were pure egoists (egoism by no means excludes culture of a kind) and had not attained to the idea of altruism—which is the one thing needful to impart civilisation as well as culture.

The natural attitude of the South Sea Islander towards the white-skinned intruder was from the first and is today—so far as this attitude of mind has not been modified by the imposition of the entirely alien idea of altruism—that "everything is mine, as long as I am strong or cute enough to take it, and only that is thine which you are able to take from me." This original attitude of mind of the islanders before they first and suddenly came in contact with civilised men, has necessarily been much blurred and obscured during the century and a half since that contact first took place by the imposition of the ideas of civilised men (based on altruism), but it still more or less persists. The mixture has been, as it were, mechanical and not chemical.

This "mechanical" mixture of two different mentalities accounts for much that would otherwise be unintelligible in the relations of the islanders and the Europeans.

Spaniards, in the great days of Spain, first penetrated into the Pacific, before unknown to the world, and for some two centuries crossed and recrossed its waters, from south-east to north-west, to bring the wealth of the East Indies, by way of Spanish America, to Spain; and in their wake followed the buccaneers and circumnavigators (it is sometimes hard to distinguish the one from the other) to singe the beard of the King of Spain, and to prey on his Royal galleons.

And at a very little later time (1642-43) the Dutch, under Tasman, from Batavia, discovered what we now call Australia and New Zealand, and penetrated into the south-west Pacific as far as the Friendly Isles (Tongo), afterwards making their exit by way of the north of Australia and New Guinea.

But these early Spanish and Dutch enterprises hardly pentrated into what we call "the Islands," and certainly established no friendly nor permanent relations with the islanders.

England rightly claims the chief share in the earliest investigation of the islands, and in the establishment of relations with the islanders. Captain Sam Wallis, of H.M.S. "Dolphin," in 1767, seems to have been actually the first to effect this, by his visit and short stay at Tahiti, living on very friendly terms with the islanders, and thereby first beginning permanently friendly relations between westerners and any of the Pacific islanders.

Two years later Lieut. James Cook, of H.M.S. "Endeavor," revisited Tahiti, early in that long series of voyages in which he and his men made the first real examination of the Pacific Islands as a whole, and of the east coast of Australia.

It is hardly necessary to say that one early and most important result of Cook's work was the establishment of the first European settlement in Australia, *i. e.*, Port Jackson, originally intended as a convict station, but which was in reality the small seed from which sprang not only the now great Dominion of Australia, but also its great daughter, New Zealand.

But there is more need to recall, for the fact is more often overlooked, that Port Jackson was the cause which led to the spread of people of European race throughout the islands. For it was this first European settlement in the Pacific that attracted and made possible the South Sea whale and seal fishery, which brought so many ships from the New England Colonies and the Atlantic shore of America into those seas.

Moreover, it was from Port Jackson that the first European trade to the islands originated—for pork and for sandalwood.

The important trade in pork between Port Jackson, which in those early days was always in dire straits for provisions, and Tahiti is a curious story which cannot be told here; but it may be noted that the ships passing for this purpose between Port Jackson and the Tahiti of Captain Sam Wallis played a considerable share in the distribution of white men through the islands.

The sandalwood trade to Fiji claims fuller notice; for though the incident was of considerable importance, it has been almost entirely forgotten. All the reference books repeat the story first told by Missionary Williams (in or about 1858) that "about the year 1804 a number of convicts escaped from New South Wales and settled among the (Fiji) Islands, and that these were the first settlers in that group." Williams adds that these white men gathered together in a small settlement at Levuka in 1815. It is generally added that the first real settlement in Fiji was made by the missionaries from Tonga in 1837.

By a fortunate chance full and detailed evidence has lately come into my possession that from 1804 to 1813 a very considerable number of ships from Port Jackson and from New England visited and lay often for considerable periods at these islands—in Bua Bay in Vanua Levu, not the islet of Bau off Viti Levu—taking in sandalwood, which was cut by the islanders, and that, though the sandalwood trade practically ceased in or soon after 1813, the accessible trees all having been cut down, and the relations between the visiting sailors and the natives having become too strained, a considerable number of white residents were left in the islands, chiefly at Levuka, and generally in more or less friendly relations with the natives.

In passing it may be noticed that after sandalwood had been cleared out from the Fiji Islands, this particular trade passed, first eastward to the Marquesas Islands—not many years after these islands had been exploited by Captain David Porter of the American privateer "Essex"—and then to the New Hebrides, where it still lingers in desultory fashion.

Returning to the case of Fiji as an illustration of the way in which European influence "penetrated" into these islands, after the sandalwood trade ceased, American vessels from New England not infrequently called there on their way to and from China, and between these visits left representatives behind—to collect *bêche-de-mer*—very largely in request to make soup for the Chinaman.

In this way a considerable, and it must be confessed somewhat lawless, body of Europeans—of several nationalities, but mostly English and Americans—became domiciled in the islands among the islanders, the relations between the white men and the naitves being usually more or less friendly, but with pretty frequent rows. But it must always be remembered that during this period there was, as far as was known, nothing to be got from the islands except natural produce collected by the natives, and none of it in great request in the markets of the outer world.

I must go back for a moment to Captain Cook's time and the French exploration of the islands, and with it to the scattering of Frenchmen among the islands. Probably these French visits, at first at any rate, were

*From the Journal of the Royal Society of Arts.

connected with a vague desire of establishing a Terre Napoleon, and were continued that France might do her share of exploring work. Also after French settlers in the islands had become numerous, the French did some keeping of order, mostly by punitive expeditions, when outrages by natives against Frenchmen had been reported.

The French in 1840-42, on the ground of disputes between the French Roman Catholic missionaries and the natives, established a protectorate over Tahiti; and in 1853 they took possession of New Caledonia, as a convict station, thus first establishing their flag in any of the islands.

The fact has already been mentioned that during the first half of last century, New England ships traversed the Pacific more numerously perhaps than those from any other country. The United States of America Exploring Expedition (1838 to 1842), under Commodore Charles Wilkes, was sent as a consequence. His survey of the islands and rocks is complementary to that of Captain Cook, and is the basis of our hydrographic knowledge of the island area. And Wilkes's many-volumed report is by far the most valuable record of the circumstances of the islanders as they were after the first forty years' intimate contact with Europeans.

Meanwhile the Germans, during the period under consideration—it is only fair to remember that it was before the days of United Germany—naturally had not acquired any holding in the Pacific, but, characteristically, had absorbed far more of their share of the trade with the islanders. Up to now the trade had been entirely in natural products, and latterly perhaps chiefly in native-grown coconuts. The small German traders were scattered singly or in twos and threes throughout the islands. Most of these came, about 1857, under the influence of the Hamburg firm of John Cæsar Godeffroy & Son, operating from its centre in Samoa very widely through the islands. This company was afterwards reconstructed under the extraordinary long name of the "*Deutsche Handels-und Plantagen Gesellschaft der Sudsee-Inseln zu Hamburg.*" It had acquired much land in Samoa, and it had fallen more or less under Government control, and it probably had much weight in subsequently getting, but not till 1899, Samoa, or rather the main part of it, assigned to Germany.

With the seventies of last century political changes began to occur in that which had so long been the No Man's Land of the Pacific Islands.

Something other than a natural produce was found which, for a time at least, could be profitably grown in the Fiji Islands. This was cotton, and men flocked there from Australia and New Zealand, both of which colonies had long protested vehemently, but till then vainly, that England should annex Fiji, and there establish a stable government in place of the mongrel constitution which had been patched up jointly by the white settlers and the natives under the so-called "King" Cakabou, really only one of the great Fijian chiefs. In 1874, when cotton was failing, and when it was impossible longer to bear with the state of anarchy which had arisen in Fiji, England yielded and accepted the cession to the Crown of this whole group of islands, which henceforward became a British Crown Colony.

Early in the seventies Germany, then recently "united," started a colonial policy, and at any rate, as far as the Pacific is concerned, it worked by fostering large commercial companies, such as the old-established one whose long name I have already quoted, and other even greater concerns, which it promoted and supported, apparently with the express intention of claiming political rights over all places where these companies gradually acquired preponderating, or even exclusive influence among the natives. When the ground had thus been prepared, it raised its Imperial flag, without protest from any one except the Australians and New Zealanders—who were after all really the most interested parties—over a large part of the Pacific coast of New Guinea and over the large and important adjoining islands of New Britain, New Ireland and New Hanover, all originally brought under some sort of civilised influence by missionaries of British origin, as well as a whole host of the smaller islands and groups of islands which surround these main islands. It has always seemed a work of impudent supererogation that the Germans changed the good old names of New Britain, New Ireland, and the Duke of York's Island to Neu Pommern, Neu Mecklenburg and Neu Lauenburg. The whole of the group which they thus formed for themselves they called the Bismarck Archipelago, though it is more than probable that Bismarck himself would have denied the wisdom of this Imperial new acquisition.

France, though long in power over the "Society Islands," which it is convenient, if not quite correct, to speak of as "Tahiti," did not definitely and finally anex these till 1880-1887.

The United States, though, as in the French case to which reference has just been made, long in real and practical authority, took in the Hawaiian group only in 1898.

Even after all this there were islands, many of considerable size and importance, in which no one Power had complete control, *e. g.*, the Solomon Islands and the New Hebrides, in the first named of which British and German influences were mixed; while in the second British and French, the last chiefly from New Caledonia, were inextricably mixed; and much more to the east the Samoan group, in which were British, Germans, and Americans. At last, in 1899, by the treaty of Samoa, these almost last of the then unclaimed islands were assigned. The Solomon Islands became definitely British, except the large but least developed northern island of Bougainville. Of the two tiny islands called Pleasant, or Nauru Island, and Ocean, or Panaba Island, each a valuable lump of phosphate rock, the former was assigned to Germany and the latter to Great Britain. Samoa fell to Germany with the important exception that Pago-Pago, with its almost first-rate and very beautiful harbor, went to America.

Thus the partition of the Pacific was for the time complete, for Tonga, sometimes said to be the last remaining independent native kingdom of the Pacific, is practically under exclusive British protection.

In the strange case of the New Hebrides, by the Anglo-French Convention of 1906, a Condominium of France and England was established.

Let us glance for a moment at the value, strategic and economic, of the share in the islands assigned to each of the Powers concerned.

Germany in Kaiser Wilhelm's Land—German New Guinea—held a strategic position of enormous value for the purpose which she presumably had in view—that is as a naval base to be used against Australia and Japan; and in this same compact group of possessions she had, but hardly used, a very large area of land available for the cultivation of tropical products; a very large area as compared with the total extent of such land in the whole of the other islands. Moreover, in the groups of small islands, or rather atolls, north of the Bismarck Archipelago, she had ample opportunity for the collection of native products; and in Nauru, small as the island is, she had one of the most valuable properties within this ocean. In Samoa she had a property of great potential value, if she had been inclined to develop this, but, owing to its isolation from her other possessions, of no real strategic value. It must have been a bitter pill to her to yield the splendid harbor of Pago-Pago to the Americans, under the Samoan Treaty of 1899.

France had and has New Caledonia, which has always seemed to me potentially the most valuable of the islands of the Pacific. But she took it as a convict station, and has done very little to develop its economic wealth, and now that she has ceased to use it as a convict station, she does not seem to have increased her efforts to develop its great potential mineral riches. In the New Hebrides, where the influence of France runs conjointly with that of Great Britain, her interest seems rather sentimental than real. In the great group of small islands of which Tahiti is the best known, she has a delightful and romantic possession, but perhaps of no very great economic value. However this may be, in the two small island groups of the Horne and Wallis Islands, she has something that is of value to her only in that they lie midway between New Caledonia and Tahiti.

America, in the Hawaiian Islands, has a splendid economic property, and has developed it to a degree perhaps unknown elsewhere in the Pacific Islands. Its value to her as a half-way house to the Philippine Islands is obvious. The strategic value to America of Pago-Pago is as a naval base.

The British islands are very scattered, but in a sense more valuable to us as being scattered far along the seaway from Australia to America. And, in the Fiji Group and in the Solomon Islands Britain has, for purposes of tropical agriculture, the most valuable asset in the Pacific, perhaps not even excepting the Hawaiian Group.

On the whole, therefore, it seems to me that the partition of the Pacific, as it stood just before 1914, was equitable, except in the one particular that it gave to Germany at least an equal share with the other Powers, though she had done least to earn it, and had, it now appears—Australia always said so—the worst intentions in claiming a share at all.

Then the storm of war broke. I was in Australia on that memorable 4th of August, and for some weeks after; and I know, we all know, how promptly and successfully, the moment the chance came, Australia sprang at the German possessions in and about New Guinea, and how New Zealand did the same for German Samoa. And we know also how readily Japan ousted the Germans from the islands which they had held to the north from New Guinea.

I have never from the first moment been able to conceive the possibility of these very temporary possessions of Germany in the Pacific being returned to her, unless in the still more inconceivable event of a German victory having been achieved. At any rate, all danger of the return to Germany of her colonies is now over.

But what has still to come is the re-partition of the islands. And what may happen in that sorting I do not pretend to prophesy. I have always thought that eventually the whole of what are, and may become, British possessions, must pass into one Australasian Federation, but that the time for that has not yet come. For the present, if the rearrangement were left to me, I would leave Kaiser Wilhelm's Land and the Bismarck Archipelago—of course, changing the names—to Australia; I would leave German Samoa to New Zealand; and I would—for the present—develop a strong Crown Colony out of the Fiji and Tongan groups, with the New Hebrides and all the Solomon Islands, and the Gilbert and Ellice Islands, definitely including with the latter the two phosphate islands of Nauru and Ocean Islands, and I would leave the other small islands away to the north to Japan.

A World Language

At University College, Mr. H. E. Palmer recently delivered the third of a series of four public lectures upon the formation of an international language which would meet with general adoption and approbation of the various civilised nationalities.

The lecturer said: "There are many rival languages on the face of the globe. Let us now, once and for all, form a commission and decide which one is most worthy of support, or which one is best fitted to serve as the basis for the final solution." The first serious attempt of that character appeared to have come from France in 1856, when the "Société Internationale de Linguistique" proposed among other things to propagate the idea of a universal language, to define its conditions, to group its elements, and prepare the way for its establishment. Twenty-three members were appointed, and they came to the conclusion that the international language must possess a scientific character, be clear, easy, rational, logical, philosophical, rich, harmonious, and elastic. Consequently, all "natural" languages were excluded, and it was held that the international language could not be modified or perfected from any of them. In 1888 the American Philosophical Society, after drawing up a report, invited all the learned societies of the world to form an international committee to invent a universal language for the needs of commerce, correspondence, conversation, and science. About twenty societies accepted the invitation. But the London Philosophical Society declined it.

In 1900, as a result of the Paris Exhibition, a delegation for the adoption of an international auxiliary language was formed, and decided to adopt the principle of Esperanto, under the reserve of certain modifications to be exacted by the permanent committee and by the Ido scheme.

Unhappily the mass of the Esperantists took up the same attitude as the Volapükists of twenty years before. "You can take our language or leave it," they declared. "We refuse to modify it, for it cannot be modified. It is the living language of the Esperanto people." All negotiations proved fruitless, and the Esperantists refused to effect the slightest reform. From that time onwards the committee of the delegation considered themselves free to effect the necessary reforms themselves, to produce new dictionaries and grammars, and to propagate the reformed and simplified Esperanto. Dr. Zamenhof, however, forbade the use of the name Esperanto in connection with the modified scheme; and the committee gave it the conventional name of Ido (*i. e.*, a descendant). The Idists were joined by the progressist Esperantists, and for seven years they worked continuously at the perfecting of the language. In 1914 they considered the state of progress so near to that of ideal perfection that a period of ten years' stability was declared, during which time further reforms could be discussed, but not incorporated. Consequently, no more official changes would be made in Ido until 1924.—*English Mechanic.*

"Ersatz" Fatal to Wild Animals

Reports from Germany state that the wild animals in the Berlin "Zoo" do not take kindly to the food substitutes that constitute their bill of fare, and many have died as a result of this enforced diet.

Twilight in the Canyon de Chelly, Arizona, from 300 feet above the valley

Remains of cliff dwellings on a ledge of the overhanging cliffs

Canyon de Chelly of Arizona

A Monument of Pre-Historic America

ONE of the most marvelous pages of American History has never been written, and perhaps never will be, yet the page is there silent, mystic, wonderful to behold in the eyes of the twentieth century, giving them a glimpse of an era, when the world was still young.

Built upon ledges and natural caves located on the face of unscalable cliffs, the pioneer tourist may see the crumbling ruins of ancient habitations, the handiwork of an unknown civilization, amid surroundings so impressive and of such magnitude that at first it is incomprehensible and then awesome and unforgettable.

Canyon de Chelly, Canyon del Muerto and the Canyon of Monuments (the latter two being tributaries of the former) are the scenes wherein one may delve deep into the history of Pre-America.

Within one hundred miles of a great railway, easily reached in two days with a motor car by way of St. Michails and Canado Trading Posts to Chinle, one can get horses for the canyon trip, yet it is little known and seldom visited. It is regretful that so much American money is spent in foreign travel when within our own borders we can find such unsurpassable scenes as in Canyon de Chelly, the Rainbow Bridge and its wonderful trail, the Grand Canyon of the Colorado and many others. Among these, Canyon de Chelly is unique in its scenes. Unlike the Grand Canyon, it is small enough to be fully appreciated, and large enough to hold one spell bound with its massive walls of red sand stone that rise perpendicularly out of the river bed for nearly two thousand feet.

Chinle Trading Post is only a few miles from the mouth of the canyon. Here the traveler may obtain food and lodging, as well as his outfit and guide. It is an interesting place; the bottom part of the building is given over entirely to a store well patronized by the Navajo Indians, many of them very interesting characters. The upper part of the block house contains accommodations for the trader and the tourist.

One mile from the trading post is the Government School and Mission, an interesting community of romping Indian children. Five miles beyond is the entrance to the canyon proper. From here, and for the rest of the journey, it is necessary to follow the lead of the guide on account of the numerous stretches of quicksand. The trail follows the bed of the Rio de Chelly; in the dry season it is very shallow, but the element of chance and excitement is always there. The canyon winds and turns forming gigantic cathedral spires of rock, fantastic rock walls often resembling colossal creatures of monumental rock.

Near the junction of Canyon del Muerto, high up on the side of a tremendous overhanging cliff, nearly two thousand feet in height, is the famous White House, the finest specimen of ancient cliff dwellings in the world. The face of this mighty wall of rock is very smooth, practically unbroken to its very top, and overhangs the canyon floor about one hundred and fifty feet, so that its face is untouched by the elements of destruction, except by the water that finds its way down the concave wall, forming dark ribbons of weather worn rock. A hundred feet from the bottom is a solitary gash in its smooth surface, about forty feet high, and perhaps two hundred feet wide, and one hundred feet deep, forming a huge cave. On the very brink of its mouth almost a continuation of the sheer walls, is built the White House, a beautiful contrast against the blackness of the huge cave. Imposing and wonderful to behold from across the sandy river, it is still more wonderful to study this citadel closely, and our imagination may well run riot, for here is, undoubtedly, a castle of a Pre-Historic potentate. From its walls he could survey the canyon in both directions, at his feet a hundred feet below him, lay a great community dwelling of his subjects, over a score of rooms

Distant view of the White House in the canyon

have walls still standing, but a thousand centuries of time and the river has destroyed much.

From whence came these people? That they had some degree of civilization is undeniable, for they built substantial homes and community dwellings out of brick, such as was used in building the great wall of China twenty-one centuries ago. That they were ruled by a King or other Potentate is plainly seen by regal aspect of the White House, as compared with thousands of other dwellings. Almost at every glance we find new evidences of a unique civilization; not that of early history, but a civilization that existed in the time pre-historic to mammoth animal life. The inhabitants of the canyon today are the Navajo Indians, but there is a striking contrast between the mud and straw hogans that look exactly like a mound of earth, and the well finished brick work of the cliff dwellers.

Canyon del Muerto, meaning Canyon of Death, derived its name from the massacre of Navajo Indians in 1804, by the Spaniards, in reprisal against the Indians. Del Muerto is of the same formation as de Chelly, and contains hundreds of cliff dwellings, some of them six and seven hundred feet up on the sides of the precipitous walls of rock. A short ten-mile trip is sufficient for Canyon del Muerto, and the traveler does well to resume his journey in de Chelly, the latter being much larger and contains other ruins almost as interesting as the White House, and other natural features of striking interest.

The Antelope ruins, a little further up the canyon, can be scaled with a little effort on the part of the traveler, enabling him to get a close view of a Kiva or Council Chamber, amid the ruins of about sixty rooms, built close against the overhanging wall, and two hundred feet above the river bed. Here one may see hieroglyphics, but their origin is doubtful, seemingly too crude for the advanced style of building. The view from these ruins is magnificent, the canyon making a great sweep, the river, reflecting the light of the sky, winding out of sight behind the gigantic cliffs. At sunset these red cliffs seem to glow with living fire, reflecting the light of the setting sun, the river becomes a ribbon of molten gold, the shadows become purple, and the sky a deep blue, against which the fiery cliffs stand out in strong contrast.

The present inhabitants of these canyons are Navajo Indians and in the shadows of the great wall, high above on the very face of the cliff are scores of goats and sheep, driven there for the night by their Indian owner. The Navajo Indians are pastorial; their wealth is sheep and goats; the former producing the wool from which are made the well known Navajo rugs. In many sections of the canyon there are fertile grazing grounds upon which we may see large flocks of sheep, and an occasional Indian hogan.

All of these Indians still live the same as in the days of the Spaniards; they are shy and unapproachable, unless your Indian guide is known to them. Alongside their hogans we may see the outdoor looms and the weaving of rugs, from shearing the sheep and carding of the wool, to the brilliant finished product, the Navajo blanket.

As we proceed up the canyon, some of the rock formations change somewhat, it looses some of its regularity, becomes wilder and rougher, but more fantastic. On rounding one of the numerous bends of the face of another gigantic wall, is the window. It looks small from the valley floor, for it is eight hundred feet above us. If you try to climb it you will think that it is three times as high, but it is worth it, for that little opening is a hundred feet in height, and forms a passage through the heart of the mighty wall.

Towering monuments in the canyon 1,800 feet high

Elephant rock seen from the White House

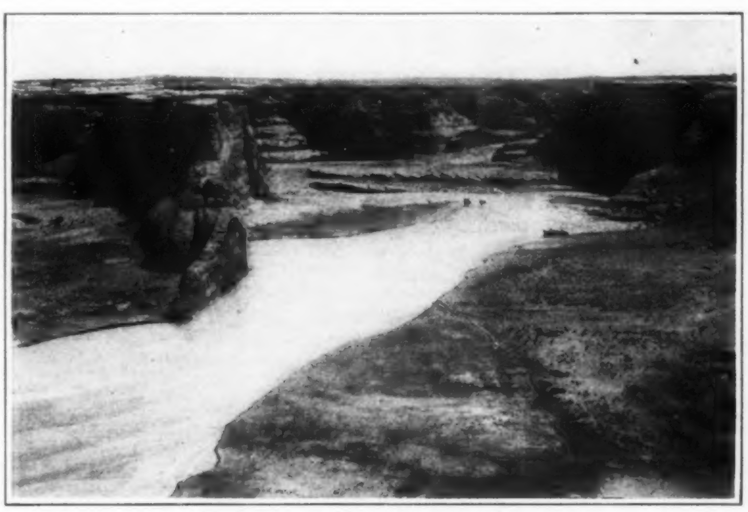
Almost across from it is another peculiarity of nature, a cleft in the canyon wall, that extends from the very rim almost to the river bed, fifteen hundred feet below, as if some gigantic axe wielded by the hand of Vulcan had split it asunder. It is weird and picturesque, and each turn opens to us more vistas, each one seemingly trying to outshine the other. At times it seems that we have seen about every conceivable phase of nature in rock building, and when we are firmly convnced of this fact, there opens before us the monuments of Monument Canyon, another tributary of de Chelly.

The canyon broadens, and from its sandy wastes, there rises pinnacle after pinnacle of the most inconceivable forms, as sheer as a plumb line, and apparently extending into the very heavens. Distances are deceptive. In front of our cavalcade are the guides, bold and clear in the shimmering sunlight; in the distance high above us the tops of the monuments are outlined sharply against the sky. Steadily we advance towards them, but they seem to grow no larger, while one of our guides riding far ahead of the rest of the party has vanished into the base of one of the mighty structures.

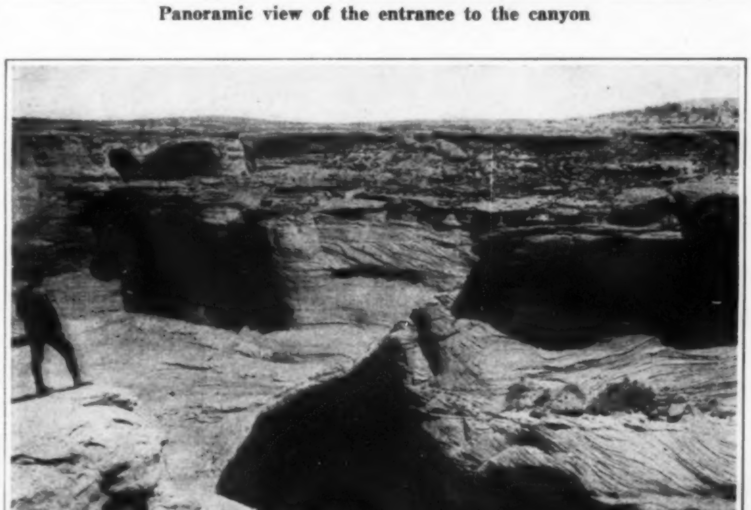
About us are sheer walls and imposing creations of rock, stately and forbidding, like grim sentinels, guarding the secrets of centuries of time. Around the lofty crags an eagle is soaring, uttering its shrill cries at the disturbers of the peaceful solitude. One feels as if he was a visitor to another planet, all is so strange, so weird, almost unbelievable. The atmosphere is of the Arabian nights, more so, when at twilight the valley is in shadow, but the tops of the mighty monuments are aglow with the reflections of the setting sun, torches of fiery rock against a sky of the richest purple.

Four nights can well be spent in the canyon. The altitude is around six thousand feet, and the atmosphere, although quite cool, is very dry. Wrapped in your blankets, you gaze heavenward. The stars are wonderful in their brilliancy, the sombre peaks are so high as to be but faintly outlined against the heavens. About you are your companions and Indians; the latter perhaps singing their old war songs, mostly a chant of three or four notes, ending every few moments with a long, shrill drawn out note that echoes and re-echoes, back and forth across the canyon walls.

Yet this is America, within a hundred miles of a great railroad, at the very threshold of modernism can be found this page of the Pre-Americas. Must these scenes be transplanted to foregin countries to be really visited and appreciated, r will the American find his own within his own land?



Panoramic view of the entrance to the canyon



Fantastic rock formations frequent in this locality

Concrete Ships Not Efficient Carriers

The outlook for concrete shipbuilding cannot be said to be promising as shipbuilders are not disposed to look upon concrete hulls as likely to compete with those of steel. The demand of steel for war purposes will decline and there will be a considerable amount available for use for ship construction. Because of the superiority of this material concrete shipbuilding will not be likely to come into favor as the extra weight stands opposed to the concrete ship as an efficient carrier and as a consequence would not prove a paying investment. Regarding the concrete type of vessels, the Liverpool *Journal of Commerce* says: "The promoters of concrete shipbuilding have had an absolutely unique opportunity of giving their ideas a thorough trial, but it can scarcely be claimed that they have achieved any measure of success either in this country or even in the United States. In fact, reinforced concrete has, so far, absolutely failed to justify itself as a suitable combination of material for general ship construction, simply because the extra weight of the vessel itself, as compared with a steel ship, makes it an uneconomical business proposition. Concrete ships are a failure, and are likely to be a failure because they are, and are likely to be, considerably heavier than steel ships. That disability alone condemns them as efficient cargo carriers," and in conclusion this journal says: "Although with considerable regret, it must be admitted that all the evidence so far produced tends to the conclusion that no reputable shipowner would care to invest capital in a concrete ship. The proposition is not a paying one, and this is a damning disability." It is certain that shipowners on this side of the Atlantic do not expect that concrete ships for deep sea service will prove a success. The experiment of employing the concrete steamship Faith in this service does not demonstrate other than that she has thus far proved seaworthy but this is apart from what her value as a cargo carrier may be.—*The Maritime Register.*

Coke Formation

Experiments by Georges Charpy and Marcel Godchot, described in the *Comptes Rendus* of August 26th, 1918, show how necessary or desirable it is to study the favorable coking conditions for every coal. Having made some general experiments last year, they proceeded to study mixtures, taking in the first instance a coal from Brassac, containing only 11 per cent. of volatile matter, and a Durham coal with 24 per cent. of volatile constituents. Mixtures of the two coals in different proportions were coked at 700 deg. C., and the cokes obtained were submitted to crushing tests; mixtures containing 25 per cent, 44 per cent., 51 per cent. and 56 per cent. of the Durham coal gave cokes of strengths 24 kg., 45 kg., 80 kg., and *nil* kg. per square centimeter. Thus the strength of the coke increased to a maximum as more Durham coal was used, but dropped off suddenly when the percentage of Durham coal exceeded 51; alone the Durham coal gave a poor, friable coke, and the Brassac coal would not coke. The best average contents of volatile matter in this mixture was 19.6 per cent., and a mixture of Durham and Cardiff coals also gave its maximum strength for 19 per cent. of volatile matter. Tar and pitch were likewise used with good results to improve the coking properties of meager coal. Another series of experiments was undertaken to ascertain whether low temperature distillation at 450 deg. C., followed by coking at 700 deg. C., would give good results. Again a curve with a decided maximum was obtained, demonstrating that in such operations the suitable temperature and duration of the heating period should be predetermined by careful experiments. When the distillation (at 450 deg. C.) was conducted for 0, 30, 90, 105, 120, 150 and 160 minutes, the percentages of volatile constituents remaining in the coal amounted to 28, 23.5, 21.6, 20, 18, 16.6 and 14.8; the subsequent coking gave a very friable product in the first three cases; in the other four cases the strength of the coke was 41, 97 and 25—very small. Thus to obtain a good coke this Durham coal should not be heated to 450 deg. C. for more than 105 minutes; too long or too short heating yielded a poor coke.—*Engineering.*

How Plants and Animals Utilize Color

Pigments that Protect Living Matter Against Radiation

The well-known French naturalist, Mr. J. Dufrénoy, of the Biological Station at Arcachon, is an authority upon the function of color in living creatures. This function is twofold: In the first place, it protects living protoplasms and biochemical agents against an excess of radiation, especially against the ultra-violet or actinic rays; and secondly, it transforms solar energy so as to make it utilizable by the organism. In a recent article in the Revue Générale de Sciences he gives some interesting examples of such utilization of color as follows:

I. Among animals the pigmentation of the coat bears a direct relation to the degree of illumination present in the environment, but even among polar animals, whose skin is uniformly white, it takes on a deeper color in the vicinity of the generative and sensory organs. The Russian grayhounds, which course over vast steppes, under a burning sun, have no dark pigment except in the muzzle, the ears, the eyes and the surrounding skin.[1]

II. Among plants the anthocyanines have only a secondary protective rôle, since they do not appear until autumn, when there has been a decrease in the intensity of light; it is mainly the flavones which protect the organs by arresting the ultra-violet rays at the periphery of the plant. The derivatives of the flavones, which are exceedingly common in plants, are found in the yellow coloring matters of the cellular juice and in solution in the cellular juice of the epidermis and the adjoining tissues. Their protective rôle can be deduced from their special abundance in tropical plants and those in the mountainous regions. The aerial parts of plants which grow on the upper slopes of mountains are generally richer in flavones than those of plants grown on the plains, and when mountain plants are cultivated on plains they lose their richness in flavones. Anthocyanines and flavones supplement each other in their protective action, the former protecting flowers of vivid color and the latter acting as a screen in the case of white or yellow flowers.[2]

III. Deciduous green leaves which turn red in the autumn contain a considerable proportion of flavones.[3] The anthocyanines in leaves proceed from the reduction of the flavones at the end of the vegetative period; Combes, in fact, succeeded in 1913 in producing the anthocyanine of red leaves synthetically, by reduction of the corresponding compound or flavone of green leaves. Reciprocally, the yellow pigment (flavone) of the green leaves of the five leaved ivy can be obtained experimentally outside the organism by the oxidation of the red pigment found in autumn leaves.[4] The anthocyanines seem to be formed also by the oxidation of colorless chromogenes. Few plants are entirely lacking in chromogenes, but the formation of pigment or the non-coloration of the flower depend upon the degree of hydration; if we extract water from the tissues the activity of the oxydase is reduced and that of the reducer is increased; in other words the formation of pigment is arrested, and the existing pigment is reduced to a chromogene and the flower becomes colorless. If, on the other hand, water be supplied to the colorless tissues the activity of the oxydase will be resumed, the chromogenes will be oxydised and pigments will be produced.[5] These facts can be observed in nature: in a field of buckwheat, for example, half of which was irrigated, the other half being dry, the leaves of the irrigated plants turned red ten days earlier than those of the dry plants.

IV. The solar energy absorbed by the pigments is largely converted into heat.[6] In January at Arachon, on a fine day, the temperature of the plants exposed to the sun exceeds that of the air by from 6 to 8° C. at noon, and by from 12 to 15° C. at 3 p. m.; the amount of this rise in temperature varies according to the color and to the intensity of the pigmentation, so that a difference of more than one degree Centigrade may exist between the yellow and the green leaves of the variegated foliage of a spindle tree, or even between the two borders of a single variegated leaf.

Experiments made in January at Arcachon gave the following results:

In a variegated leaf of the *Iris pallida* the green portion showed a rise in temperature of 9.8° C. over that of the air against a rise of only 8.5° C. in the yellow portion. Similar observations were made with the red and green leaves of an arbutus, the time being 10 a. m. and the temperature of the air 10° C. (50° F.); in this case the red leaf showed a rise of 7.5° C., and the green leaf a rise of only 7° C. At 4 p. m., when the temperature of the air was 11° C. (51.8° F.), the green leaf had gained 14° C., its temperature being 25° C. (77° F.). Under the same circumstances green algae (*Enteromorpha*) showed a rise of 7° C. and brown algae one of 10° C. Experiments with xerophites showed that the leaf of the *Atriplex halimus* under these conditions showed a rise of 13.2° C., and that of the Eucalyptus one of 14° C. Among the fungi the white capped mushroom showed an increase in temperature of 4.5° C. and the dark violet mushroom one of 8.5° C. These last tests were made in November, the temperature of the air being 10° C.

In the same month tests were made at 2 p. m. with red and white arbutus berries, the temperature of the latter being 29.5° C. and that of the white fruit a degree lower.

Finally experiments were made with grapes of various colors placed in sunshine and in shade.[7] The temperature of the red grapes in the sun was 37° C. and 10° C. less in the shade; that of white, green and amber colored grapes was 34° C. in the sun and 26° C. in the shade. The time of this last experiment was Oct. 10, at 3 p. m., the temperature of the air being 24° C. in the shade. A second experiment showed that grapes with a dull surface had a temperature of 35.5° C. in the sun, whereas that of those with a bright surface was 34.8° C.

A highly interesting fact is that every rise of 10° C. in the temperature of the organs exposed to sunlight doubles or even trebles the rapidity of the reactions observed—for example, the intensity of respiration is greatly enhanced,[7] more carbon dioxide being liberated.

In fruits exposed to sunlight the plant acids contained are reduced, and the ripening is correspondingly hastened[7]. . . .

Green algae (*Entermorpha*) or brown algae (*Fucus*) taken into the sunlight show a rise in temperature within 15 seconds if the light be strong, and in 30 seconds if it be feeble.

The beginning in the rise in temperature coincides with that of the disengagement of bubbles of oxygen. This rise is hardly ever more than 1° C., and the equilibrium reaches its maximum at the end of a minute; later the algae heat the water in contact with them and the elevation of the temperature becomes a linear function of the time.

The algae carried again into the shade lose this excess of 1° C. in 15 minutes. This sort of heating of shallow waters in contact with aquatic vegetation undoubtedly raises the thermic balance of ponds and basins along the shores of seas and streams, and it is the heat of the summer sun absorbed by plant pigments which such sheets of water store up for winter use; the study of this relation appears to have been thus far neglected.

V. The pigmentary utilization of energy found in nature ought to be made use of by man through experiments designed to increase it or diminish it where necessary.

1. Selection should be employed to breed plants and animals whose pigmentation is most favorable to the ends in view.

It is to be hoped that by means of methodic research the protective and assimilative value of the various pigments in plants may be determined, and also the relation of the pigmentation to the production of reserve stores such as starches, fats, etc., and secretions such as resin and the like.

Among domestic animals the selection of black or strongly pigment races, such as local conditions, have made necessary in Algeria and in Virginia,[8] would be advantageous everywhere.[9]

2. Denuded soil should have its vegetable covering restored, for wooded land stores up an infinitely larger number of calories than bare ground.

3. The use of absorbant screens artificially colored, such as those employed by the Olaa Sugar Co. of Hawaii, should be generally adopted. The fields of sugar cane are covered with tar paper immediately after the harvest; since only the young canes, with their stiff sharp points, are able to pierce this, the softer weeds are smothered; moreover the calorific energy absorbed by the paper heats the soil to such an extent that the crop is increased by an average of 10 tons to the acre.[10]

To sum the matter up there are few questions so important as that of pigments, since they are the protectors of living matter against radiation, and it is exclusively through them that the solar energy is utilized and stored up.[11]

[1]Solger: Signif. of Skin Color, *Die Umschau*, p. 370, 1911.

[2]Shibata and Kishida: Appearance and Phys. Signif. of the Flavone Derivatives, Bot. Mag., Tokio, vol. XXIX, pp. 316-332, 1915; quoted from the *Bot. Gaz.*, vol. LXII, p. 164, 1916.

[3]Shibata, Nagata, and Kishida: J. Biol. Chem., vol. XXVIII, p. 93, 1916-17; quoted from *Bot. Gaz.*, vol. LXIV, p. 260, Sep. 1917.

[4]Combes, cited by André: Ch. Agric., p. 273, 1915.

[5]Keeble, Armstrong & Jones: Form. of Anthocyan. Pigm. in Plants, Royal Soc. of London, Feb. 27, 1913; quoted from *Rev. Gen. d. Sc.*, May 30, 1913, p. 410.

[6]The temperature of the needles of the *Pinus Laricio* in winter exceeds that of the surrounding air by from 2 to 10° C.; 650 tests made in February between 8 a. m. and 3 p. m. showed an average excess of 3.6° C. (Ehlers: Temp. of Leaves of P. in Winter, *Am. Jour. Bot.*, 1915). The temperature of the Giant Bamboo often exceeds that of the air by 6° C.; the excess of the Cactus is frequently as much as 9° C. (Mac Dougal). At Tucson, in July, 1916, the temp. of some of the *Opuntias* was 55° C. (131° F.). McGee: Carneg. Inst. Yearbk., 1916, p. 73.

[7]M. A. Muentz: Cult. and Managing of the Vines, *Ann. of Agronom. Sc. in France and Other Lands*, p. 223-9, 1895.

[8]In Virginia the root of an Amaryllis (daffodil) (*Lachnantes*) possesses the property of tinging the bones of pigs who feed on it pink and of causing the shedding of the hoofs of all the white varieties; for this reason only black swine are raised. Cvénot: The Genesis of *Animal Species*, pp. 237 and 142.

[9]In the mountains the sheep with white heads suffer greatly from the heat of the sun; they cease to pasture and seek the shade of trees or of neighboring animals, or else, turning their backs towards the sun they bend their heads and shelter them in the shade of their own bodies.

[10]*Sc. Am.*, p. 267, Oct. 13, 1917.

[11]On the same subject see: Ch. Td. Guillaume: Radiations and Transformism, *Sev. G. d. Sc.*, vol. X, p. 185, 1899.

G. Dupont: The Distrib. of Temp. in Living Plants, *Ibid.*, vol. XXIV, p. 418, 1913.

Rodillon: The Corolla as a Reflector of Heat, *Ibid.*, vol. 23, p. 804, 1912.

The Infl. of the Ultra Violet Rays on Plants, *Ibid.*, vol. XXIII, p. 496, 1912.

The Biol. Rôle of Ult. Viol. Rays, *Ibid.*, vol. XXII, p. 352, 1911.

J. Dufrénoy: The Biol. Signif. of Essences and Pigments, *Ibid.*, vol. XXVIII, pp. 575 to 580 inc., 1917. (Reproduced in SCIENTIFIC AMERICAN SUPPLEMENT).

Ibid. The Ecologic Conditions of the Devel. of Fungus Parasites, Bull. of French Soc. of Mycology (to appear).

Ibid. and R. Molinery: The Climatology of Bareges. *La Med.* therm. et. chin. (Medicine in Relation to Heat and Climate), vol. II, pp. 155-8, Nov., 1917.

Paper-Making from Megass

SOME particulars are given in the *West India Committee Circular* of a project to construct a megass-paper mill at Olaa, Hawaii, capable of manufacturing 16½ tons of paper a day. Its purpose primarily will be to produce the heavy mulching paper experimentally adopted in Olaa last year as a means of preventing the growth of weeds in the early stages of the sugar-cane crop. It is said, however, that the mill can be made to manufacture other papers of many grades, ranging from the ordinary brown wrapping paper and cardboard to super-calendered stock such as that used by magazines.

The amount of bagasse required for the output of 16½ tons a day will take only about 10 per cent. of all bagasse created in the Olaa mills, and this first plant will be so built that additions may be made later, until the entire bagasse out-turn may be utilised if that is found advisable and desirable. If megass paper proves all that is predicted for it, Olaa eventually should be producing something like 165 tons of paper a day. Should the project prove thoroughly successful in every way, and should it be taken up by the other plantations of the islands, it will develop a new industry in Hawaii, second in importance only to that of sugar production.

However, the Olaa mill probably will not be ready for operation within a year. The machinery is being ordered now, but because of war conditions in the eastern factories and in the arteries of transportation, no one can tell when the equipment will be delivered.

Increasing Pressure by Means of Electrolysis

IT is a well-known fact that water is decomposed by an electric current, the rate of decompositon being 0.3354 gms. by one ampere of current in one hour. The products of that quantity of water are 0.416 litres of hydrogen and 0.208 litres of oxygen. If, when suitable arrangements for setting up hydraulic pressure have been made, a current be passed through the water, decomposition will take place, and the generated gases will produce pressure of any desired intensity. The writer tells of pressures so produced as high as 1,860 atmospheres.—*Chemiker-Zeitung.*

Industrial Waste Products—Methods of Reclamation

Among the varied problems, brought into prominence by war conditions is that of the recovery and utilization of products which have hitherto been regarded as waste. The purpose of the present article is therefore to offer a few notes on the processes available for effecting such recovery, and to indicate their value from the commercial point of view. It is not intended to refer to the recovery of by-products, such as ammonia, from gas plants, but to deal with the waste products which are to be met with more generally in engineering workshops, manufactories, and domestic life.

RECOVERY OF OIL.

Engineers and manufacturers of all classes are agreed that the collection of metal scrap to be melted down on the works premises or to be sold on contract to metal refiners, is sound commercial practice. Apparently, however, scant attention has been given to the oil carried away with this scrap. In some cases, indeed, this loss has been realized, and the scrap has been subjected to a casual sort of drainage before being passed on to the scrap heap, but by that means only about 30 per cent. of the oil is actually recovered. The recovery can be effected much more efficiently by the employment of a centrifugal separator of which there are various makes on the market. To cite a typical instance of the results obtained, a prominent motor-car manufacturing firm, by installing a turbine-centrifugal separator, utilizing steam for the dual purpose of propellant and liquefier, recovered 1,200 gallons of cutting oil a week, the oil being used over and over again on similar work, while the fresh oil needed to make up for wastage from all sources amounted to only 10 per cent. of the total required. Another firm, specializing in cycles and cycle parts, recovered by means of a similar machine 2,292 gallons of oil from 834 cwt. of miscellaneous metal turnings in a period of six months.

The advantage of the use of steam for liquefying the oil in the process of centrifugal separation can be judged from an average test made upon two separate charges of fine brass swarf supplied by a concern manufacturing agricultural machinery. The first charge, consisting of swarf weighing 23 lb. 9 oz., when taken direct from the machines and treated in the steam turbine centrifugal separator, yielded one pint 2 oz. of oil; while a charge of identically the same material, after having been passed through a centrifugal of the ordinary belt-driven type not using steam, yielded one pint 2 oz. from 24 lb. 7 oz. of the swarf.

WIPING MATERIALS.

The oil contained in cotton waste, rags and sponge cloths used for cleaning machinery, mopping up oil, or wiping work in the course of manufacture, deserves more consideration than it usually receives. It has been proved in numerous instances that such materials thrown away after first use were, owing to the oil contained in them, of greater value than the cost of new materials. In addition to the recovery of the oil, the wiping material itself can be treated and made suitable for repeated use with little loss or injury to its texture and qualities. In an installation of the most complete type for this purpose the dirty material received from the shops is first passed through a turbine separator similar to that referred to for dealing with metal turnings, in order to extract the oil from the wipers; incidentally it should be noted that the steam used for liquefying the oil also permeates the wiping material and sweetens it. The oil thus recovered is passed on to settling tanks or to filters of the filter-pad, gravity, or centrifugal type, according to the quantity to be dealt with, for purification; and after this process it is ready for re-use. Experience has shown that the oil does not lose any of its qualities, this confirming what might be reasonably expected, since the oil is not a "used" but rather a "spilt" oil.

To revert to the material from which the oil has been extracted, in cases where it has been used for comparatively clean work, such as wiping down engines in power houses or for mopping purposes, it is ready for re-use it comes from the separator. When, however, material has been used on dirtier work it is advisable to wash it in a machine closely resembling the ordinary laundry machine, and then partially dry it (in large installations) in a hydro-extractor of the regular type as a preliminary to final drying in cabinets or automatic rotary machines.

COMMERCIAL RESULTS.

An analysis of the working accounts, covering a period of three months, of such a plant designed to turn out six tons of clean dry rags a week, the capital expenditure on which would be approximately £2,200, showed a net saving of a little more than £450, after due allowance had been made for coal, water, electricity, rent, rates, collection, wages, and insurance. The reclaimed rags and oil amounted to 67 tons and 4,080 gallons respectively. The reclaimed oil was used as fuel for Diesel engines. On a similar but considerably smaller plant, costing £210, the working accounts for one year showed a recovery of 5,000 gallons of oil. For 350,000 cloths treated annually, only 15,000 new cloths had to be purchased to make up for losses from all sources, representing a loss of only 4.3 per cent. of the quantity treated. The net saving on the year was £102 12s. 6d., after allowing for repairs, interest on first cost, &c.

An engineering concern on the South Coast carried out an interesting experiment, comparing their expenditure on sponge cloths and waste over two successive years. During the first year these materials were sent out to be washed at an ordinary laundry; during the second year they were treated in a small plant of the kind mentioned above, costing £125. In the 12 months after this plant was started the saving in new sponge cloths and waste purchased amounted to £37 1s. and £51 5s. respectively, while the oil reclaimed totalled 716 gallons and was valued at £11 15s. The net saving, after making deductions for power, wages, and interest on outlay, was returned as £32.

VARIED APPLICATIONS.

The scope of the process is very wide, and practically all forms of waste products susceptible to heat and centrifugal force are successfully reclaimed, including such diverse materials as wax, compositions, and fibres in candle and match manufacture, inks and turpentine from type and roller wipers in printing works, and various chemicals in chemical works. Fats, kernels, kitchen and table refuse, residues, &c., are among the materials also efficiently treated by means of the steam turbine extractor.

Another de-oiling process for dealing with such materials as are referred to above consists in passing a chemical solvent through them, the oil being carried away with the solvent and finally distilled off under high vacuum. This method, however, requires more or less skilled attention, the solvent is rather expensive, and the fabrics, though not subjected to mechanical action, are liable to damage by chemical action.

TIN CANS.

The problem of used tins and canisters suggests itself even to the layman's mind whenever the subject of waste products is referred to. The recovery of solder from such articles has been practised in this country for several years, but until quite recently processes for the de-tinning of the steel scrap were practically confined to Germany. All the processes known are more or less based on chemical or electrolytic action, or a combination of the two. So far as is at present known, electrolytic means must be adopted in order to recover the tin in its metallic form. The treatment of the scrap by dissolving off the tin from the sheet steel with weak acids results in the formation of tin salts; at the same time the liability of the steel itself to be attacked by the acids has to be borne in mind. Much use is made of the affinity of chlorine for tin. Thus in one process the charges of scrap are placed in suitably arranged cylinders and dry chlorine gas admitted. The gas combining with the tin froms tin tetrachloride, which incidentally may be used as a by-product of very considerable value in the manufacture of artificial silk. On subjecting the tetrachloride thus formed to electrolytic action metallic tin and stannous chloride are produced; the chloride on being further electrolysed splits up into tin and chlorine, the latter re-uniting with part of the stannous chloride to form tin tetrachloride for repeating the operation.

What is probably the latest process of de-tinning, as developed in this country, is briefly as follows: The canisters are first passed through rolls for the purpose of perforating them, and then through a hot solution of caustic soda in order to remove all organic matter in the shape of paper, varnish, fats, &c. The tin stripped from the scrap under the action of the caustic soda leaves a clean steel scrap and a sodium stannate solution. The latter, on being treated electrolytically, deposits the tin on the cathodes in a spongy state, and this is removed from time to time and reduced to its metallic form in a liquidating furnace. The clean steel scrap is pressed by hydraulic or other means, into bundles of convenient size for re-melting. The organic matter is separately treated and recovered. A plant of this type capable of dealing with about 15 tons of scrap a week and recovering about 3 cwt. of tin of 98 per cent. purity would require, when working continuously during a 53-hours week, approximately 20 kw.

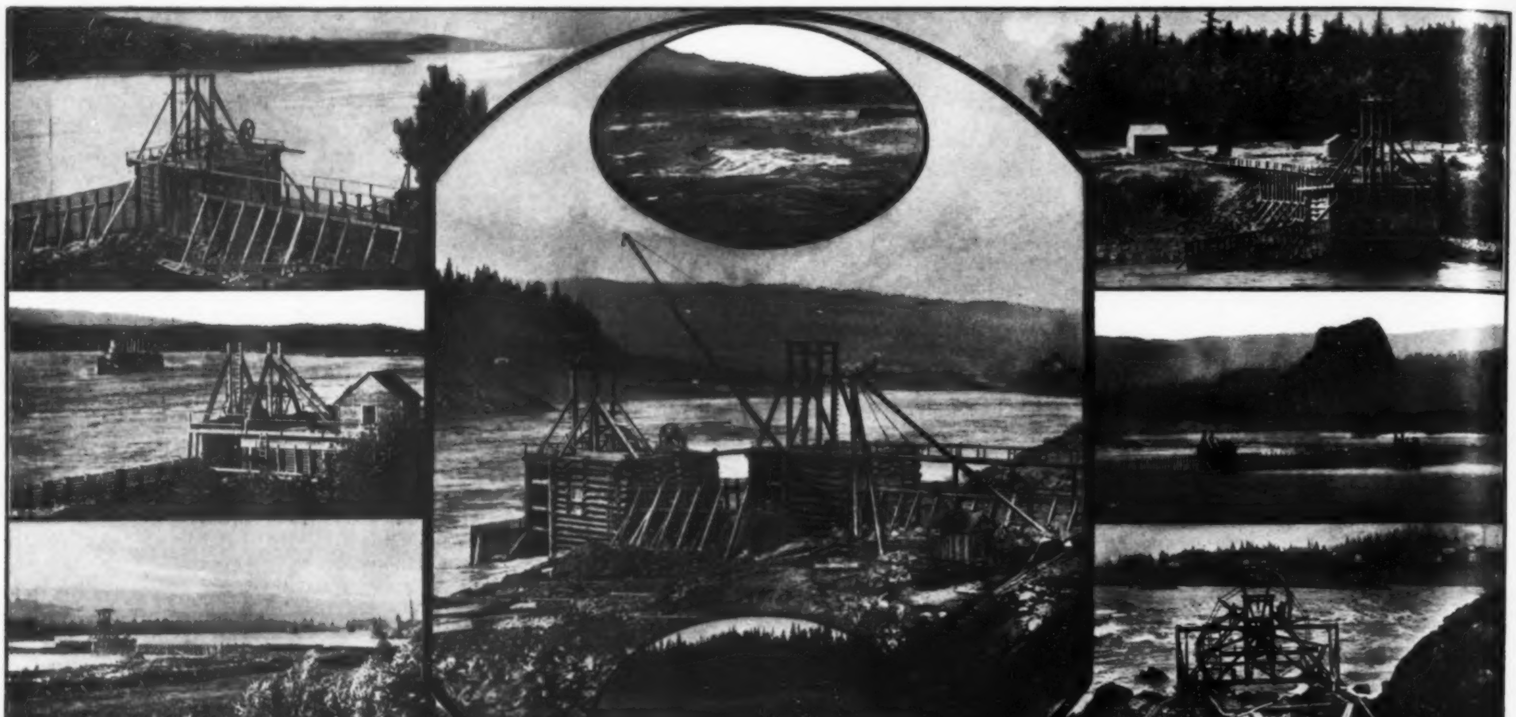
Though much has been done in the past, the ever increasing price of raw materials and the difficulty of obtaining supplies have rendered this interesting subject one of really prime importance, and there is a wide field for immediate research.—*London Times Engineering Supplement.*

Carbide Formation and Stability

Reviewing his recent work on carbides in a paper read before the Bunsen Gesellschaft, in April last, Professor Otto Ruff, of Breslau, pointed out that our knowledge concerning the formation and stability of the carbides and their valency relations was very defective. Qualitatively Moissan's work, to which Ruff seems to attach a higher degree of reliability than many chemists would ascribe to it, was admirable; the establishment of the quantitative relations, however, was very difficult. Owing to the retention of gas by carbon and their partial liberation at high temperatures it was hardly possible to maintain a vacuum of 3 mm. or 5 mm. of mercury in vacuum carbon furnaces which had first been filled with ordinary gases. Nitrogen, hydrogen and carbon monoxide combined with carbon above 2,000 deg. C., and the compounds were decomposed again at lower temperatures, so that a transference of carbon from spots of higher temperature to spots of lower temperature took place in the furnaces. To avoid this Ruff works in an argon atmosphere. In his lecture he referred in particular to the carbides of aluminum and of chromium as typical in certain respects. The liquid aluminium metal, he stated, dissolved little carbon, but it readily formed the solid carbide Al_4C_3, which was not fusible at atmospheric pressure, but evaporated at high temperatures, probably as such; all the carbides, however, seemed to decompose at very high temperatures. Chromium, on the other hand, dissolved carbon readily when fused, and formed fusible carbides which evaporated, but not without decomposition. One of the great difficulties was to exclude nitrogen which was bound by most carbides. In the case of aluminium, the carbide Al_4C_3, when free of nitrogen, evaporated without melting at temperatures up to 2,200 deg. C.; then it melted at a pressure of 400 mm., decomposing partly into graphite and aluminium. Ruff and his collaborators have not yet succeeded in directly analysing the vapors of this carbide; the vapors seem to be richer in carbon at high temperature and pressures, however, than at lower temperatures and pressures. As regards chromium, when the liquid metal was saturated with carbon, boiling was observed at 2,270 deg., and the vapor then consisted entirely of chromium. Between 2,050 deg. and 2,250 deg. the carbon percentage in the melt remained fairly constant, and the composition corresponded to the formula Cr_3C_2 as the temperature was lowered to 1,875 deg. The carbide mentioned existed side by side with graphite; there was also evidence of the existence of the carbide Cr_5C_2. From similar experiments with many other metals it would appear that in an atmosphere of hydrogen, nitrogen or carbon monoxide, saturated with carbon, all oxides can be transformed into carbides or reduced to metals; the reactions depend upon the fusibility of the oxides or products and their capability of dissolving carbon. A great many carbides seem to exist, corresponding in their formulæ to CH_4, C_2H_6, C_2H_4, C_2H_2, C_4H_{10}. In these carbides the heavy metals appear to have lower valencies than they possess in other compounds, and the valency sometimes decreases as the temperature is raised; thus tungsten gives the carbides WC, W_2C, W_3C. The common carbides of iron and manganese are Fe_3 and Mn_3C.—*Engineering.*

Theory and Practice of Disinfection by Alcohol

The disinfecting power of alcohol cannot be associated entirely with its property of precipitating the proteins of bacteria, because those concentrations of various alcohols which cause the same amount of precipitation of a protein differ greatly in their disinfecting efficiency. One of the most important factors in disinfection is the capacity of the disinfectant to penetrate the cell-walls of the bacteria, and this is largely determined by the surface tension of the disinfectant. Of all the alcohols, propyl alcohol appears to possess the most valuable qualities required by a disinfectant for direct application to the epidermis prior to surgical operations. Its solutions have lower surface tensions than solutions of corresponding concentrations of ethyl alcohol, which has hitherto been largely employed in this connection. Moreover, the toxicity of propyl alcohol is at least four times as great as that of ethyl alcohol, and, owing to its greater solvent power for fats, it is able to enter readily the pores of the skin.—*Note in J. Soc. Chem. Ind. on an article by J. Christianson in Z. Physiol. Chem.*



Construction details of fishwheels, the use of which has revolutionized the fishing industry

Left upper: A good illustration of the outside and inside leads of a fishwheel. Notice the braces to hold them in place. *Left middle:* Another picture showing the outside lead in high water. *Left lower:* A picture showing six fishwheels.

Center upper: Rapids at Cascade Locks, Oregon, at high water. *Center middle:* A fishwheel in construction at Cascade Locks, Oregon. *Center lower:* High water on the Columbia. The crib of this fishwheel is forty feet high and is under water. Part of the inside lead is destroyed.

Right upper: This fishwheel was built by A. G. Vanstrom in 1893. It has withstood the high-water of every season for twenty years and is still catching thousands of dollars' worth of fish every year. *Right middle:* The fishwheel to the left was built at a cost of $10,000. Owing to the way the fishwheel sets in the current, it has caught but a few hundred dollars worth of fish in five years. *Lower right:* A new method of removing the wheel in high water. The crib of this wheel is under water. This is also a good illustration of the construction of the wheel.

Fishing by Machinery

How Salmon Are Caught on Our North-West Coast

In the rapid development of the many industries of the West there are none that have shown more improvement along scientific lines than the fishing industry.

It would have been interesting to have seen the Indian of the Columbia River fishing with a dip net, constructed of a long pole with a hoop at the end covered with net in order that we might compare this mode of fishing with the modern fish wheel of today. How has this great change come about? Not by one rapid bound, but by thirty-five years of labor and experimenting.

The first fishwheel on the Columbia River was built in 1878 by Mr. Williams. He was prohibited, however, from obtaining a patent on it owing to the influence of Mr. McCord, a rival in the fishing business. Mr. McCord brought evidence to bear that fishwheels had been built in South America more than a hundred years ago. The fishwheels in South America must have been very small and crude, and they seem to have gone out of existence.

Mr. Williams secured a patent on a scow-wheel in 1883. One of the accompanying photographs is a good illustration of the scow-wheel, which consists of a large scow with a wheel attached at one end. The scow-wheel was for several years considered the best means of catching fish, but the inconvenience of moving the scow with the rise and fall of the water resulted in a great loss of fish. The South American method, which consisted of a small crib of logs filled with rock, and a wheel attached to the outside, finally became the most popular. This is the plan on which the fishwheel of today is built, but the latter is built on a larger scale and much improved.

Great sums of money have been expended by large corporations in improving the fishwheel, and sometimes the experiments have resulted in total failures. At times the high water of the spring seasons has taken the wheel away and at other times it would not run for want of the right amount of current. Thus the problem of location has become one of great study in the building of a fishwheel. The fish run in certain channels, and to determine where these channels are is a difficult matter. In swift water the fish stay close in towards shore, and a wheel placed at some projecting point will generally catch great quantities of fish. Where the current is not so swift, and the water is deeper, the fish stay further from shore. Here it is necessary to construct long leads to direct the fish into the wheel.

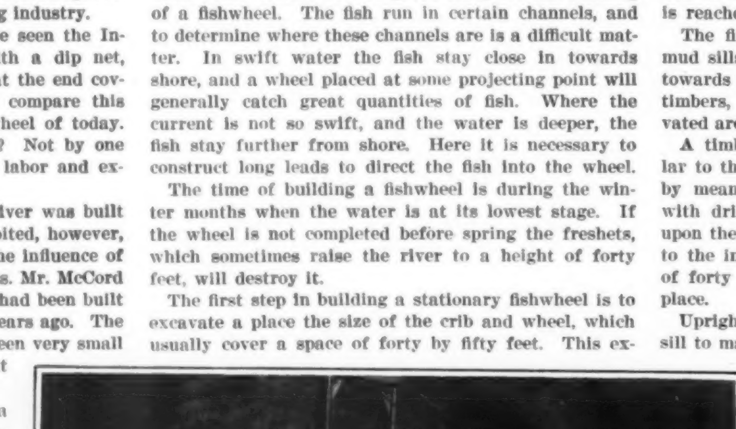
The time of building a fishwheel is during the winter months when the water is at its lowest stage. If the wheel is not completed before spring the freshets, which sometimes raise the river to a height of forty feet, will destroy it.

The first step in building a stationary fishwheel is to excavate a place the size of the crib and wheel, which usually cover a space of forty by fifty feet. This excavating is done by means of a derrick and is continued to a depth of ten feet or until a solid foundation is reached.

The first two timbers of the foundation are called mud sills. They are placed ten feet apart on the side towards the river and parallel with the current. Cross timbers, running the entire length of the place excavated are placed upon these mud sills.

A timbering process is then begun, somewhat similar to the raising of a log house, the logs being raised by means of a derrick and bolted securely together with drift bolts. The crib, as this is called, is built upon the timbers placed across the mud-sills, extending to the inside mud-sill. The crib is raised to a height of forty feet and then filled with rocks to hold it in place.

Upright posts are then placed upon the outside mudsill to make the other side of the wheelway. This wall of timbers is bolted to the crib with logs running from each end of the crib. This leaves a space of ten feet open between the crib and the outside wall for the wheel, which is to catch the fish.



A scow-wheel. The dips and the fish chutes of this wheel are similar to those of a stationary fishwheel

The long timbers, seventy feet in length, are placed upright on each side of the wheelway, about six feet apart. These four timbers are called jins. Between them are built frames for supporting the axle of the wheel. These frames can be raised and lowered by means of a windlass which enables the fisherman to comply with the Sunday fishing law.

The next step is to construct two leads made of piling with two by fours nailed on the upper side. The first is built from the outside of the wheel into the river, slanting enough down stream to lead the fish into the wheel as they come swimming up the river.

Extending the outside lead is one of the most important and hardest parts of the fishwheel to build. If it is not slanted enough, the fish will not follow it into the wheel, but will go around the end. This

lead usually runs so far out that it is hard to make it solid enough to withstand the current, which, as government statistics show, runs from eight to ten miles per hour. Large quantities of cement are often used to hold these leads from washing away.

Another lead is built from the crib to shore which also leads the fish into the wheel. At the top of this inside lead is placed a walk which makes it possible to reach the crib.

The wheel itself is built somewhat similar to an ordinary wheel on a steamboat, but is considerably larger, measuring about forty-four feet in diameter. After the spokes have been fitted in place, three curved dips are run to the center of the wheel. These dips are covered with heavy wire netting. At the end of each dip, near the axle of the wheel, there is a chute slanting towards the crib. When the fish strikes this chute they slide into the fish box, which is in the crib. As the current turns the wheel slowly around there are always two dips in the water while the other is emptying its fish into the fish-box.

Fish of all descriptions and sizes are caught by these wheels, some weighing less than one pound and others weighing seven and eight hundred pounds. Among the most common of these are Chinook Salmon, Blue Backs, Steel Heads, White Salmon and Sturgeon.

There is no doubt but that in the years to come the fishwheel will take the place of all other modes of fishing where there is enough current and a sufficient amount of fish.

The Mentality of the War Prisoner

PRISONERS' camps in all parts of Europe are being broken up, and the early return of our own prisoners of war and of civilian internés from enemy countries is expected. Much has been written, but little is definitely known, about their mental well-being, and we welcome a little pamphlet[1] of 50 pages by Dr. A. L. Vischer, of Basle, devoted to the study of the psychology of prisoners of war, and especially to what was first called the "barbed-wire disease" in an agreement for exchange made between this country and Germany in July, 1917. Dr. Vischer is a surgeon in Basle, and does not claim for himself special experience in mental affections, but he has himself spent much time in various prisoners' camps in different countries (he was attached to the Swiss Consulate in London), has conversed with hundreds of prisoners, and learned to know many of them. His experience is therefore first-hand, and he claims that it is important owing to the fact that 4 or 5 million men have been kept in confinement in enemy countries, and that many of them will return with impaired mentality to their homes. Dr. Vischer is well read in his subject and accepts Dr. F. W. Mott's dictum (*The Lancet*, Jan. 26th, 1918) that hysteria and severe neurasthenia are seldom seen in prisoners' camps; but he draws a picture of a mentality characteristic of prisoners of war, to which the majority fall victim within two or three months and from which few escape completely. The factors in its causation he considers to be partly the monotonous and scanty food-supply, the absence of fresh air, the circumstances of their incarceration, the loss of personal freedom, and the loneliness; summing up in one sentence the three basal factors as follows—loss of liberty for an unknown period in close company with many others. The result is a continual longing with entire inability to perform. The factor of loneliness in the midst of company he illustrates from writings emanating from various camps. A little poem entitled "Legereinsamkeit," from Knockaloe, begins with the stanza—

Kein Plätzchen in der Hütte,
Kein Fuss breit Platz im Freien,
Wo du nur auf Sekunden
Mal könntest einsam sein—

which may be compared with a passage from Gaston Riou's "Journal d'un Simple Soldat," which runs:

"......vivre entre hommes, rien qu'entre hommes, tous les jours, toutes les nuits cœr à cœur, bec à bec, griffe à griffe, sans activité, sans solitude, sans la compagnie de femmes—c'est autre solitude,—oui, c'est cela le purgatoire!"

And in the midst of loneliness "the barbed wire draws itself like a red thread" through his whole world of thoughts. Not only so, but it impels him to resistance. The prisoner finds himself obliged to kick against the pricks. He is always on the defensive, and begins to complain not only of the management of the camp, but also of his friends and relatives, and this not only in word but in writing. The camp magazines of all countries show a marked resemblance in this respect. In the German camps the prevailing feeling is one of mistrust, which especially takes the form of suspecting those who bring the post. In camp jargon, the postal officials are supposed to be always "trying it on," which is an inadequate translation of the German "Schiebung." The word constantly recurs in the records of the camp satirists. Briefly, the camp community consists of people who hope and wait together, and in so doing become wearied in mind and soul. Some find outlet in gambling, many in the familiar occupation of "grousing." Rumor plays a large part in camp life. Reports which are not at first actually believed circulate freely, so that the whole camp population may pack their things at night in preparation for a departure on the morrow, of which there was no reasonable prospect. Ruhleben has been described by an inmate as the "City of Futility." Even the best-educated has to struggle to perform mental work of any kind. Concentration becomes ever more difficult. Restlessness sets in, with mental fatigue, on the slightest exertion, whether of mind or body. Lack of memory is a frequent complaint. The depression as it increases involves disinclination to speak, and gradually the full picture develops of what is called "Stacheldraht-Fieber," and familiarly "grauer Vogel," or in French, "cafard." Dr. Vischer found many grades of the affection, but is unable to give any idea of the proportion of severe cases. He instances 3 out of 30 in one hut, 50 out of several hundred in one camp. Cases are more marked as well as more numerous among internés than prisoners of war for the reason, Dr. Vischer thinks, that the former are often people who left their homes in order to find a freer existence elsewhere, and are therefore peculiarly intolerant of restraint. His statement is noteworthy that bad and even brutal treatment does not produce the disease, while good treatment does not keep it in check. Even a charming site for the camp is no prophylactic, as those will guess who have had to deal with sick folk kept for long periods away from home in beautiful surroundings. In regard to recovery he can say but little, except that the condition is not cured at once on leaving the camp. When it is in any way highly marked recovery may require a long time. Many of the internés gave him the impression of broken people. An old general who visited a number of his own officers and privates interned in Switzerland frankly admitted that he could not understand them, nor they him. The latter part of Dr. Vischer's monograph is given up to an interesting comparison of barbed-wire disease with other similar conditions. Napoleon in St. Helena suffered from an "irritation nerveuse considérable." The "mentalité grégaire" of isolated military colonies, the mass illusions of seamen becalmed on the equator, the trivial quarrels of polar explorers, the frequent neurasthenia noted in the French maritime service; all these he finds nearly akin. In all may appear the irritability, the ideas of suicide and persecution, the various obsessions, and the desire for solitude and isolation. The polar explorer has the most intimate points of similarity with the prisoner of war, with the great difference that his incarceration is voluntary. Dr. Vischer concludes with an expression of thankfulness at the share which Switzerland has taken in mitigating the prolonged isolation of the war prisoner.—*The Lancet.*

[1]Die Stacheldraht-Krankheit: Beiträge zur Psychologie des Kriegsgefangenen. 1918. Rascher and Cie., Zurich. Fr. 1.60.

Work Done by 1,500,000 Horses in France During the War

AFTER the battle of Verdun, in which the French held their lines against the desperate and protracted onslaughts of the German Crown Prince, with troops and munitions rushed forward almost wholly by automobile transport, some one called this a gasoline war, and this appeared to be true, in some measure. The wonders of modern army transport, the quickness with which large bodies of men and huge quantities of supplies are moved have become commonplace. The automobile does all the work. So it is recorded, and so it has been accepted, and the horse has not figured much in the calculations. However, the Billets and Remounts Division of G—1, which is charged with the responsibility of equipping and supplying the A.E.F. with animals for draft and riding, now comes forward with a declaration that the horse and its hybrid offspring, the mule, have played a highly important part in this war, and claims that this was still very much a horse war.

The automobile may have won at Verdun, says the Billets and Remounts Division, but the horse has figured in many victories, for say they, no victory could have been attained, no drive could have succeeded, unless the horse was on duty to pull the guns forward, to take up the rations, the water, the ammunition through mud where trucks could not go, or over shell-swept ground equally impassable for the gasoline-propelled vehicle. There were 1,500,000 horses and mules doing service for the Allied cause in France. Approximately half of them are in the Artillery service. Practically all of the field artillery of all the Allied armies below the six-inch gun, is horse-drawn. The other half worked at a multitude of duties, most of which have taken them under fire at the front. It is the horse which takes the ration cart forward over the shell-swept, shell-pitted roads to the men in the line. It is the horse which likewise takes forward the water; transports most of the small arms, ammunition and some of the artillery shells, and this work is done when conditions are the hardest and the weather the worst. With the coming of winter, with its snow, its cold and its mud, the horse begins his work in earnest. Then he keeps on while the automobile seeks firmer and safer paths behind.

The American Army had 169,000 horses and mules on active duty. This is what is left, fit for service at present, of a total of 210,000 horses and mules put into service by the Army. The rest were killed, were wounded or became sick, and are being treated in hospitals. Owing to the scarcity of ocean transport facilities, the value of an army horse in Europe is almost incalculable. His cash value is several times what it is in America, and for that reason, extraordinary means are employed for conserving the present supply. A mobile veterinary hospital is attached to each army corps, and it receives all sick and wounded horses, which there is a possibility of saving. If the case is a serious one, the animals are sent to base hospitals in France by the American Army, and it will accommodate 3,000 animals. A horse goes through the hospital about the same way a soldier does, and when he is fit, he returns to service.—*Weekly Press.*

Exposure Meters

THE modern photographer is rather apt to look with disfavor upon the exposure meter, as being the instrument of the amateur. There is, however, no reason why the photographer should not take advantage of it in some of the more difficult branches of his work, without feeling that such is in any way "infra dig." Take copying, for instance, or the photography of a piece of machinery in some engineering shop, where the light is, to say the least of it, tricky. Many hundreds of plates are doubtless wasted in the run of a year upon guess-work or experiments which the use of an exposure meter would have saved. We recently heard a photographer complain that he never got a correct exposure when relying on his meter, one of the standard patterns. Subsequent discussion elicited the fact that when he was ascertaining the "meter time" he neglected to observe a very necessary rule *i. e.*, to hold the instrument facing the light, and *not* the light reflected from the subject. The fact of the matter often is that many operators do not pay enough attention to the instructions issued with the meter. When counting the "meter time" in seconds few operators trouble to employ a watch, preferring to do their counting in their own heads. This, again, is likely to cause error, since the conception of the period of time designated "a second" is very widely different in the minds of different people. Great care to ensure accuracy is certainly not essential, but a certain approximation is necessary if the test is to have any value at all. When working under bad conditions of lighting, when the meter is most likely to be used and is certainly most valuable, the operator may grudge the long time taken in order to make the light-test. Many users of the Watkins meters are not aware that the two exposures, the meter and camera, may be made at one and the same time. By selecting a suitable stop for the plate in use, which can be found on reference to a table in the Watkins booklet, the darkening of the paper to the tint indicates that the period of exposure has been reached, thus saving all calculation. Another point that many workers overlook is that the meter should always be exposed on the worst lighted part of the subject or its equivalent, for obvious reasons. Neglect of this has often resulted in the meter being blamed for giving an incorrect reading. We do not mean to imply that a skilled photographer will need to use a meter for every ordinary exposure that he makes. For this there is certainly no need, but when working under difficult lighting conditions, or undertaking new and strange subjects, even the most expert worker can have no better assistant.—*Brit. Jour. Phot.*

Vermiform Appendix in the Wombat

THE Australian wombat, a marsupial, shares with man and some of the higher apes the distinction of being the only animal to possess a vermiform appendix. Curiously enough, the appendix has in this animal of a very ancient type made further progress toward elimination than it has in man. In a collection of specimens by Dr. W. C. Mackenzie, of Melbourne, the appendix degenerated till it almost reaches the vanishing point.

Hot Wire Anemometry*

Its Principles and Applications

By J. S. G. Thomas

When the velocity of a gas current has to be determined the usual method employed consists in the use of a Pitot tube and a sensitive tilting gauge. The Pitot tube and gauge measure the difference between the dynamic and static heads, and very approximately this difference of pressure is proportional to the square of the velocity of the gas current. In the hands of a skilled experimenter the tilting water gauge is capable of yielding accurate results, but is an instrument which cannot be placed with any degree of confidence in the hands of one unskilled in its use. Apart from this objection to the use of the Pitot tube for general works' purposes, there are certain points connected with the use of the Pitot tube which, in the opinion of some experimenters, make it questionable as to how far its indications are reliable in various circumstances. These objections to the use of the Pitot tube have been very succinctly summarised by Professor J. T. Morris.[1]

The system of anemometry with which this paper deals, depends upon the cooling experienced by a heated wire when immersed in a stream of fluid. The theoretical aspects of the problem have been considered by Fourier,[2] Poisson,[3] Boussinesq,[4] and H. A. Wilson.[5] Experimental work on the subject of the convection of heat from a heated wire has been carried out, among others, by Kennelly and Sanborn.[6] Complete references to experiments on the subject have been published by Langmuir.[7] Kennelly[8] appears to have been the first to suggest that a measurement of the current required to keep a wire at a definite temperature when immersed in a current of air might be used as a means of determining the velocity of the air current. Kennelly, Wright, and Van Bylevelt enunciated the laws of cooling of heated wires in a stream of fluid as follows: (1) The linear convection is proportional to the temperature elevation of the wire at the same wind velocity; (2) under varying wind velocities (200 to 2,000 cm. per sec.) the linear convection increases as the square root of the wind velocity.

The subject was developed independently by Morris[9] and by Bordini.[10] An integrating form of anemometer has been described by Gerdien,[11] and the principle of electric heating of a gas has been employed by C. C. Thomas[12] in his electric gas meter. Experiments in hot wire anemometry were carried out by G. A. Shakespear in 1902. An exhaustive study of the subject has been made by L. V. King,[13] who has succeeded in placing hot wire anemometry on an absolute basis, *i. e.*, he has shown how it is possible to calibrate an anemometer wire in terms of its diameter and thermometric constants, independently of the use of any other wind-measuring instrument.

As has been stated above, hot wire anemometry is based on the cooling effect experienced by a heated wire when immersed in a stream of gas at some lower temperature. The laws determining this cooling effect, its dependence upon the temperature to which the wire is heated, its dependence upon the velocity of the gas stream and upon all the other factors involved, among others the emissivity of the wire, the thermal conductivity of the gas, etc., have been thoroughly studied. Practical hot wire anemometry, then simply requires some method of determining the cooling effect of the gas stream upon the heated wire. Various methods are available and have been suggested and employed by different experimenters.[14] In some cases the temperature of the wire is maintained unaltered, extra current being pased through the wire to compensate for the cooling effect of the gas stream. This is the method employed by King.[15] The platinum wire is inserted in one arm of a Kelvin double bridge, the balancing resistance being composed of manganin, which possesses a negligible temperature coefficient. The pairs of ratio arms of the bridge are so adjusted that a balance can be obtained independently of all connecting or contact resistances. The wire is mounted at the ends of a fork, the tension of the wire being adjusted by means of a fine thread. The pairs of ratio arms are separately adjusted to equality, the bridge being thus balanced when the resistance of the anemometer wire is equal to that of the manganin wire. On inserting the anemometer wire in a stream of fluid, the bridge being balanced before insertion, the cooling of the anemometer wire by the stream upsets the balance, and an adjustment of current through the anemometer wire is made by means of a rheostat until the bridge is again balanced. King has shown that the velocity, V, of the stream is related to the current, i, necessary to restore the balance by the equation $i^2 = i_0^2 + K\sqrt{V}$; when $V=0$, $i=i_0$, so that i_0 is the current which produces a balance of the bridge in a still atmosphere. Platinum wire of 2.5 or 3 mils in diameter is found most suitable, that used in platinum thermometry being especially suitable. The wires for use as anemometer wires are calibrated by being whirled round at the end of a rotating arm. In this manner King has shown that the relation $i^2 = i_0^2 + K\sqrt{V}$ holds rigidly over the range from 17 to 800 cm. per sec., and certain results indicate that it holds over a much more extended range. At low velocities free convection currents from the wire may become sensible, altering the resultant dirction of the stream past the wire, but this error can be eliminated if the wire is calibrated suitably disposed in the stream. Using a 3 mil wire an accuracy of 1% can be obtained in the determination of a velocity of 9 cm. per sec. = 0.2 mile per hour. An investigation by King has shown that variations of atmospheric conditions have very little effect upon the velocity determinations. With regard to the effect of pressure, this, with ordinary fluctuations is negligible, and in any case, as the hot wire anemometer measures the mass flow of a gas, *i. e.*, the product of the velocity by the density of the gas, when this is required, no correction is necessary. Using a high temperature—say 1,000° C.—King has shown that to the first order of small corrections no correction is necessary for the temperature of the gas stream.

J. T. Morris has suggested various methods of use of a hot wire as an anemometer.[16] Perhaps the most suitable for general use is that contained in his Patent Specification No. 25,923 of 1913. King, it will be remembered, proposed the use of one platinum wire with large temperature coefficient of resistance, the balancing wire being of manganin with negligible temperature coefficient. Morris, on the other hand, according to the specification, proposes to make all the four wires of the bridge—a simple Wheatstone bridge is employed—of the same material, one or alternate arms of the bridge being shielded by means of a tube so that, all the resistances being adjusted to equality at any temperature, the balance is not upset with change of temperature provided there is no relative motion of the anemometer and the surrounding medium. For the purpose of calibration in Morris' experiments[17] the hot wire anomometer was inserted, together with a Pitot tube, in a wind channel, and corresponding readings taken. All four wires, shielded and unshielded, are mounted in a frame and inserted *en bloc* in the stream. Using a galvanometer device in which the deflection is proportional to the square of the current, the deflection produced by the "out-of-balance" current in the bridge is very approximately proportional to the velocity of the stream. In this form the instrument becomes robust, the various parts being such as can be employed for general works' purposes. Essentially, what is required is a Wheatstone bridge as described, a cell or cells to serve as source of current, a rheostat for maintaining constancy of current in the bridge and an indication of such constancy of current, which indication may be furnished by the galvanometer employed as the indicator of the velocity of the stream, a suitable switch being arranged for the purpose. The bridge wires, if being used for the determination of the total-mass flow of air or gas in a main, can be inserted either at the centre of the main or at any other point where the relation of actual velocity to the mean velocity in the main is known. The indicating instrument can then be calibrated directly to indicate the quantity of air or other gas flowing in the main. Used in this form, the reading of a pointer serves to indicate the rate at which gas is flowing in a pipe. The observer has no delicate adjustment to make. The only adjustment to be made is an adjustment of the bridge current to a certain specified value by means of a rheostat. This is an adjustment which can safely be left in the hands of any workman of ordinary intelligence. A skilled observer is not required. In works where rates of flow of various fluids have to be apportioned to one another the readings of one or more hot wire anemometers will enable this to be done in a rather less empirical manner than is sometimes the case at present. Moreover, the hot wire anemometer can easily be made a recording instrument, so that a record can readily be obtained of the performance of various mains so far as the passage of air or other gas through them is concerned. King[18] has described a form of automatic recorder for use with his type of anemometer. The hot wire of the anemometer can be raised to any desired temperature, the readings of the indicating instrument, of course, being a function of the temperature. King in his experiments commonly used a wire at a temperature of 1,000° C. For ordinary purposes such elevated temperatures are quite unnecessary. The correction necessary on account of variation of atmospheric temperature is reduced with an increase of temperature of the anemometer wire, but for general purposes, where extreme accuracy is not required, a temperature of 200° C. or so is ample. Moreover, for the determination of low velocities there is an advantage in the use of a wire at moderate rather than at an elevated temperature, in that the free convection current from the wire is thereby reduced. In any case the use of bare wires heated to anything of the order of 1,000° C. is precluded in the case of gases, such as coal gas, containing combustible constituents. The possibility of ignition of the gas by the heated wire must be guarded against, and for use with combustible gases a much lower limit of temperature must be employed. Further, the author has found that using a platinum wire of 0.1 mm. diameter and fusing on to it a coating of glass, the sensitiveness of the arrangement is still such as to permit of the use of the coated wire in anemometry; in fact, the sensitiveness is very little, if at all, impaired by this treatment, if not indeed increased.[19] The reason for this apparent anomaly is analogous to that advanced by Porter in the case of the effect of lagging on the radiation from steam pipes.[20] Porter has shown that coating a wire with glass up to about 8 cm. radius increases the radiation loss from the wire as the thickness of the coat increases up to this limit. Generally, Porter has shown that there is a critical radius of lagging equal to K/e, where K is the thermal conductivity of the material of the lagging and e its emissivity, such that for values of the radius less than this critical value an increase of thickness of the lagging increases the radiation loss from the heated interior. Although the greater part of the heat loss in the anemometer wire is due to convection, similar considerations hold, and the increase of surface due to the glass coating serves to increase the effect, the wire being thin and below the limiting radius indicated by theory. This glass-coated anemometer wire is especially serviceable for use with gases easily decomposed by heat or such as are liable to contain soot or carbon from decomposed hydrocarbons. The catalytic activity of glass being in general considerably below that of plantinum, such decomposition is prevented by the use of a glass-coated wire. Directions in which the hot wire anemometer can be employed are numerous. Its use where the velocity of a gas stream is required is at once obvious, and has been discussed above. Since the action of the instrument depends upon electric current, this places at our disposal all manner of recording devices actuated by the same power. Any type of recorder employed in platinum thermometry is equally applicable as a recorder with the hot wire anemometer. Relays can be actuated by the "out of balance" current to effect certain operations, thereby rendering many operations automatic. As an example may be mentioned the operation of a valve by the "out of balance" current so that the amount of naphthalene solvent injected into a coal-gas main may be proportioned to the gas flowing in

*Journal of the Society of Industrial Chemistry.

[1]Morris. "The Electrical Measurement of Wind Velocity." Engineering, December 27, 1912.

[2]Fourier. Mémoires de l'Académie, 1820, 12, 507.

[3]Poisson. "Théorie Mathématique de la Chaleur," 1835.

[4]Boussinesq. Comptes Rend., 133, 257.

[5]Wilson. Proc. Camb. Phil. Soc., 1904, 12, 413.

[6]Kennelly & Sanborn. Amer. Phil. Soc. Proc., 1914, 55—77.

[7]Langmuir. Phys. Rev., 1912, 34, 401; Proc. Amer. I.E.E., 1912, 1011; 1913.

[8]Kennelly. Trans. A.I.E.E., 1909, 363—397.

[9]Morris. British Assoc., Sept., 1912; also Engineer, Sept. 27, 1912.

[10]Bordini. Nuovo Cimento, April, 1912; 241—283. Electrician, Nov. 22, 1912, 278.

[11]Gerdien. Ber. deuts. physik. Ges., 1913, 20.

[12]C. C. Thomas. J. Franklin Inst., 1911, 411—460.

[13]King. Phil. Trans., 1914, A. No. 520, 373—432.

[14]See, *e. g.*, Morris. Engineering, Dec. 27, 1912.

[15]L. V. King. Phil. Mag., 1915, 556. Also Phil. Trans., 1914, A., 373—432. Eng. Pat. 18,563 of 1914.

[16]Engineering, Dec. 27, 1912.

[17]Morris, *loc. cit.*

[18]Eng. Pat. 18,563 of 1914.

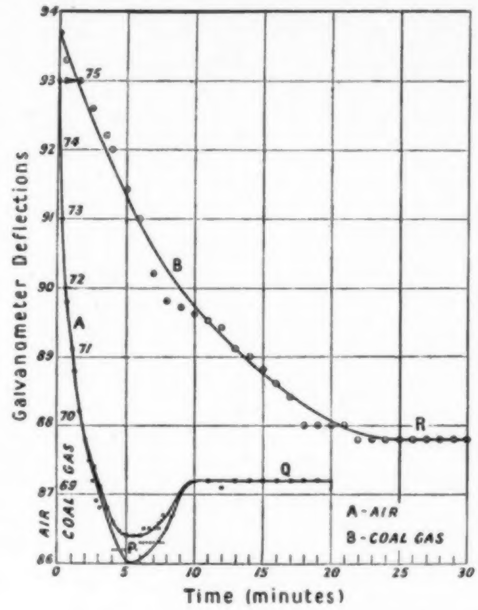
[19]Eng. Pat. 111,015 of 1917.

[20]Phil. Mag., Sept., 1910, 511—522.

the main. For the complete specification of the flow of gas in a main, as, indeed, for any vector quantity, not only must we know the amount, but also the direction, of the flow. A slight modification of the anemometer enables us to determine whether gas is flowing in one direction or the other in a main. By the use of two bare or glass-coated wires placed across the gas stream, so that one of the wires is shielded from the cooling effect of the stream by the presence of the other wire, the wire on which the stream first impinges is cooled more than the other, the "out-of-balance" current in the bridge displacing the pointer in one direction, which may be marked "up." On reversing the direction of flow of the gas stream, the pointer is displaced in the "down" direction, the shielding effect now being reversed. Owing to the extreme sensitiveness of the hot wire anemometer and its high resolving power, *i. e.*, its power to detect minute variations of gas velocities over small distances, it is a most responsive instrument in the examination of conditions of turbulent flow. King suggests the possibility of using the hot wire anemometer in order to obtain a record of the performance of a steam turbine analogous to the indicator diagram of the ordinary reciprocating engine.

As an example of the employment of the anemometer in the laboratory may be mentioned the result of an investigation suggested to the author by Dr. Charles Carpenter, *viz.*, the determination of the ratio of the volume of gas to the volume of the primary air induced in an inverted incandescent burner, and the variation of this ratio during the period when steady conditions are being established in the burner. For the purposes of experiment a Metro No. 3 inverted incandescent burner was taken. A hot wire anemometer consisting of a piece of platinum wire 0.1 mm. in diameter, glass-coated, and of about 0.6 ohm resistance, was inserted in the supply tube to the burner at some considerable distance from the heated portion of the burner and insulated from the supply tube by a plug of ebonite. The wire formed one arm of a Wheatstone bridge, the ratio arms being adjusted to 1,000 : 1. The balancing resistance was 637 ohms, with a maximum variation of $\pm$ 1 ohm during an experiment. The current in the bridge was supplied by a storage battery, and was accurately adjusted throughout by means of a rheostat to 0.8 amp., the magnitude of the current being determined by a sensitive Siemens milli-ammeter with appropriate shunt. A sensitive dead-beat Paul galvanometer was employed as indicator. The ammeter was calibrated as follows: The gas supply to the burner passed through a gas meter and sensitive balance pressure governor. The bridge was balanced when no gas was being supplied to the burner. The gas supply was then turned on and adjusted to any desired value. The steady out-of-balance deflection of the galvanometer was observed, the bridge current being adjusted to 9.8 amp. A series of observations, galvanometer deflections and hourly rates of consumption over the appropriate range of gas consumption enabled a calibration curve of the anemometer to be drawn. With regard to the determination of the volume of primary air induced by the gas, the following method was employed. The supply of primary air to the burner was drawn in through a brass tube about 6 feet long. Some little distance from the air holes of the burner the tube bifurcated, and the two limbs so formed were brazed to a cylindrical chamber surrounding the air holes. In this manner the gas issuing from the injector of the burner received a supply of gas uniformly distributed on all sides. A hot wire anemometer was inserted in the brass tube from which it was insulated by a plug of ebonite. The calibration of the anemometer was performed in the manner described above, the air being derived from the laboratory high-pressure supply and being measured by means of a wet gas meter. All volumes were corrected to 15° C. and 30 in. pressure. Both calibrations were made with the burner alight. The marked increase of sensitiveness of an anemometer when used in coal gas as compared with air is obvious from these curves. This increased sensitiveness arises from the very much greater thermal conductivity of the hydrogen contained in the coal gas as compared with that of air (hydrogen=31 $\times$ 10⁻⁵ c.g.s., air =5 $\times$ 10⁻⁵ c.g.s.). This factor makes the hot wire anemometer—particularly the glass-coated variety—eminently suitable for use with coal gas or any gas containing hydrogen.

The anemometer having been calibrated as above, the meter connected to the air supply was removed, its place being taken by a closed vessel containing water; the air induced by the burner passed over the water, so that the anemometer was, both in calibration and in use, subject to the cooling action of air saturated with water vapor. The burner was now lit and readings of the respective galvanometer deflections taken at ¼-minute intervals, the bridge current being throughout maintained at 0.8 amp. Certain deductions from these curves are not without interest. In the case of the air and the coal gas it is seen that the consumption diminishes, reaching steady values represented by Q and R respectively. The reason for the diminution of the gas consumption is not far to seek. Initially the burner is cool, but it becomes heated during the course of the



experiment. The pressure at the injector is throughout maintained constant. The suffix 1 referring to the gas in its cool condition and the suffix 2 to the gas in its final heated condition, we have, V_1 and V_2 being the respective velocities of efflux from the injector, ρ_1 and ρ_2 the respective densities—

$$\frac{V_1}{V_2}=\sqrt{\frac{\rho_2}{\rho_1}} \text{ approximately.}$$

Now, the respective volumes consumed per hour measured at same temperature and pressure are in the ratio:

$$\frac{\rho_1 V_1}{\rho_2 V_2}=\sqrt{\frac{\rho_1}{\rho_2}}.$$

Hence the respective gas consumptions are directly proportional to the square root of the respective densities. If we assume that the gas obeys Charles' law, we are enabled to estimate the temperature of the gas at the injector, for we have:

$$\frac{Q_1}{Q_2}=\sqrt{\frac{273+t_2}{273+t_1}},$$

t_1 and t_2 being the respective temperatures at which the gas consumptions are Q_1 and Q_2.

In the present case the galvanometer deflection obtained with the coal gas anemometer fell from 75.7 to a steady value 69.8. The respective gas consumptions are 4.36 and 4.05 cub. ft. per hr. The atmospheric temperature being 57° F. = 14° C., we see that the temperature of the gas at the injector is 60° C. In this manner it is possible to determine the temperature of the gas in its passage through the injector, and a knowledge of this temperature is of no inconsiderable value in connection with burner design. Pasing now to the diminution in the primary air induced into the burner, we notice that with the burner in question the final value is not attained by a continuous decrease. There is a preliminary decrease to a lower value than the final steady value followed by an increase to the final steady value. This effect is explained by the following considerations. Owing principally to the decrease of density of the heated coal gas, and its consequent diminished air-inducing capacity, together with the decreased consumption of gas in the heated condition, the volume of induced air decreases as the burner becomes heated. As indicated at P, the value of the galvanometer deflection throughout was slightly unsteady. This unsteadiness was a characteristic of the decreasing deflection throughout, but cannot be indicated on the remaining part of the diagram owing to the smallness of its amount. The air consumption does not fall steadily, but in a series of oscillations. It will be noticed that the air consumptions falls much more rapidly than the gas consumption. The presence of the oscillations and of the final descent and subsequent ascent of the curve at P can be described as an "inertia" effect. The gas and air consumption are being reduced. At any instant of time there is a certain gas and air consumption. The burner is at a certain temperature. At the subsequent instant the gas rate is reduced. The burner, however, does not cool sufficiently rapidly to enable the air rate to attain immediately its value appropriate to the new gas rate. There is a lag in the cooling, and the air consumption is reduced by an amount greater than is appropriate to the new consumption of gas, owing to the fact that the temperature of the burner is higher than its appropriate value. This will account for the dip at P and the series of "oscillations" by which the air consumption attains its final value. From the calibration curve we find that the initial and final consumptions of air, *i. e.*, when the burner is respectively cold and hot are 12.91 and 9.80 cub. ft. per hr. The air to gas ratio is therefore 12.91 ÷ 4.36 = 2.96 when burner is cold, and 9.80 ÷ 4.05 = 2.42 when burner is hot.

The well-known sharpening of the inner cone of an inverted incandescent burner as the burner becomes heated from its cold condition is therefore to be attributed to the direct effect of the pre-heating of the gaseous mixture and not to any increase in the percentage of air in the gaseous mixture, this percentage being, in fact, less in the heated than in the cold condition of the burner.

Telescopic Eyepieces

MICROSCOPIC object-glasses may sometimes be employed with great advantage as eyepieces for astronomical purposes, and I have had some very good triple-lens eyepieces and concave lenses. My object in writing this note is, however, to suggest that observers might with advantage often use a single lens when high powers are necessary. Light is saved, and definition very sharp at centre of field, but it is true the available field is very small, and with only an altazimuth mounting it is troublesome to have to keep the object central. When, however, an observer wants to get the best he can out of his eyes and instrument, as he often does, then he must have recourse to the single lens, and put up with its minor disadvantages. Herschel I. and Dawes adopted this plan, and with what result the history of astronomy affords ample proof.

When the objects to be examined are of a character to require low or moderate amplification, then the ordinary Huygenian combination is quite satisfactory. But when the power exceeds 300, I believe the single lens can be resorted to with the best results.

On a reflector of about 12¼ inches aperture, I usually found a power of 275 high enough for critical work, but of course much depended on the state of the atmosphere and nature of the object. For planetary work 300 was my favorite eyepiece, though I have used 350, 385, 405, 420, 440, and 485 with excellent effect on really good nights. A Barlow lens is a decided acquisition, for it virtually gives one a new set of eyepieces by materially increasing the powers of those on hand.

I believe that an observer should confine himself to the same powers as much as possible, even in the face of the ever-varying quality of definition. If engaged in studies of Mars or Jupiter, let him by frequent trial discover the power usually yielding the best results, and utilise this on all occasions, except perhaps when very sharp definition encourages the use of very high powers.

It is said that Short and others, many years ago, found it desirable to match certain eyepieces with certain mirrors. This may have been successfully attempted in much earlier days of telescopic construction, but I am not sure that something of the kind is not feasible with modern instruments. Imagination may easily have an influence here, but I think that one can occasionally meet with an eyepiece which seemingly acts unusually well with a particular mirror or object-glass.—*English Mechanic.*

Electric Heater for Use in the Analytical Distillation of Gasoline

NICKEL-CHROMIUM wire is wound round a mandrel of about ⅛ in. diameter, the helix thus formed is stretched out to a length of about 26 in. and then wound as a spiral on a wooden cone 2 in. high and 1¾ in. diameter at the base. The spiral is held in position by brads and a layer of alundum cement is applied over the whole to a thickness of ⅜ in. When the cement is set, the wooden cone is removed, the device dried at 100° C., and then baked at 900° C. It is attached to a stout asbestos board which forms the lid of a brass box, so that the cement cone is in an inverted position in the box when the lid is in place. The terminal wires from the cone are connected with binding screws on the lid and the dead space in the box is filled with kieselguhr, shredded asbestos, or magnesia, a silica tube being used to insulate the wire leading from the lower end of the cone. The flask to be heated rests over a hole in the lid immediately over the cone. Sliding wire rheostats are used for regulating the heat.—*J. Eng. Chem.*

The Detection of "Ghosts" in Prisms—II*

A Method of Developing Prisms Free from Undesirable Reflections

By T. Smith, B.A., (From the National Physical Laboratory)

[Concluded from Scientific American Supplement No. 2249, Page 94, February 8, 1919]

Another use for such a prism is the division of a given parallel beam into two widely separated but strictly parallel beams.

Fig. 13 shows a ray PQR which has not followed the normal path. If reflection took place at Q the deviation would be constant, thus causing a ghost. As drawn the ray would be refracted at Q, which is on an image of the emergent face, so that no light would enter this instrument in this direction. In the case of the complementary prism Q would be on the incident face, and a ghost would occur.

Fig. 14 shows the way in which the diagram may be repeated for a few special rays. L and N are on oposite faces, and the number of reflexions is odd. In most cases there will be refraction instead of reflexion at such a point as M. In the 135° prism M is on the incident face, and a ghost spectrum is formed; but in the 45° prism this point is on the emergent face, and

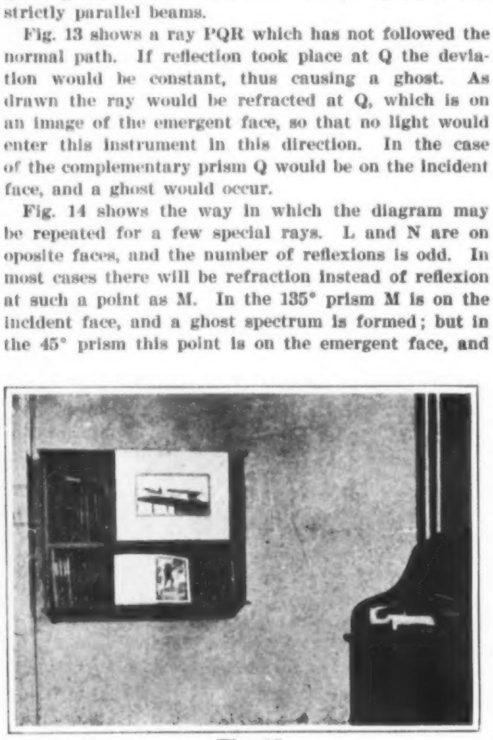


Fig. 16

no ghost occurs. Fig. 15 shows another ray which may give rise to a ghost. P is on the incident face, and the number of reflexions is even. If refraction occurs at Q, QR will result in a ghost spectrum in the 45° prism, but not in the other since in that case Q is on the emergent face. The three figures illustrate prisms in which the positions of the lines obtained in developing the diagram vary with the direction of the ray. It is only in a few special cases such as the prisms developed in Figs. 6, 9, 10, 11, 12 that all methods of development result in the same outline diagram.

It may be useful to express algebraically some of the results to which the diagrams lead in the case of isosceles triangular prisms. The two equal faces may be assumed to be of length l, and the third side, which may be called the base, is supposed to be silvered. The two allied forms of prism may be taken together, the acute form having angles

$$a, \quad \frac{\pi - a}{2}, \quad \frac{\pi - a}{2},$$

and the obtuse form angles

$$\pi - a, \quad \frac{a}{2}, \quad \frac{a}{2}.$$

Let n be the integer determined by the conditions

$$2n\, a \leq \pi \leq 2\,(n+1)\, a.$$

The properties of the prisms for rays incident normally on one of the equal faces may be simply described by supposing these faces divided up into $n + 2$ parts. Number the sections from the base towards the vertex in the acute prism, and in the reverse direction in the obtuse prism. The length of section p is

$$l\left\{\cos\,(p-1)\,a - \cos\,p\,a\right\}$$

and normal rays incident on this section behave as though they were passing through a parallel block of glass of thickness

$$l\left\{\sin\,(p-1)\,a + \sin\,p\,a\right\}$$

unless a is so small that the rays are refracted out of the prism earlier. The number of reflexions which will have taken place is $2p - 1$ for the acute prism and $4p - 3$ for the obtuse, and is thus essentially odd in both cases. Rays incident on the last section behave in a similar way if $n + 1$ is written for p in the above formulae except in that for the length of the section. The length of section $n + 2$ is

$$l\left\{\cos\,n\,a + \cos\,(n+1)\,a\right\}$$

provided this is positive; otherwise it is zero. Thus rays incident on any of the sections 1, 2, 3, . . . n, $n + 2$ will not result in achromatic ghosts of the constant deviation type. Rays incident on the $(n+1)$th section behave quite differently. The length of this section is

$$-\,l\cos\,(n+1)\,a$$

and the equivalent piece of glass when the reflexions are rectified is in general not parallel but prismatic. The angle of the equivalent prism and other particulars are given below.

Angle.	Number of Reflexions.		Face of Emergence.	
	Acute form.	Obtuse form.	Acute form.	Obtuse form.
$2na - \pi$	$2n$	$4n - 2$	Emergent	Emergent
$(2n+1)a - \pi$	$2n + 1$	$4n$	Incident	
$2(n+1)a - \pi$	$2n + 2$	$4n + 2$	Emergent	

The first angle on this list at which the ray can be refracted out of the prism is to be selected. In the last two columns "Incident" and "Emergent" are used in the senses in which they apply to light passing through one of the regular $(n + 1)$ sections. If a is an exact submultiple of a right angle this anomalous section does not exist for normal rays. In all other cases a ghost image is formed except for the acute prism having a an odd submultiple of two right angles, when the light entering the prism is refracted out at the same face and consequently does not traverse the rest of the optical system.

If the limiting points of the first n sections on the incident face are a, a^1; b, b^1; c, c^1; . . . n, n^1; and the corresponding emergent points on a given ray are denoted by capital letters, the order of these points on the emergent face is A^1, A; B^1, B; C^1, C; . . . N^1, N. If p, p^1; q, q^1 are the corresponding extremities of the $(n+1)$th $(n+2)$th sections, P^1 and Q coincide with the angular point of the prism remote from a and A^1. In the general case P P^1, unlike the other sections, is not equal to p, p^1.

Rays within the prism which are inclined to the normal to the incident face may be treated in a similar way, first finding the value of an integer m for which $m\,a$ and $(m+1)\,a$ are limits within which the value of this inclination lies.

The illustrations which have been given of the method of finding every way in which a ray may be refracted through a prism are all of a simple character. The method may however be applied with ease to very

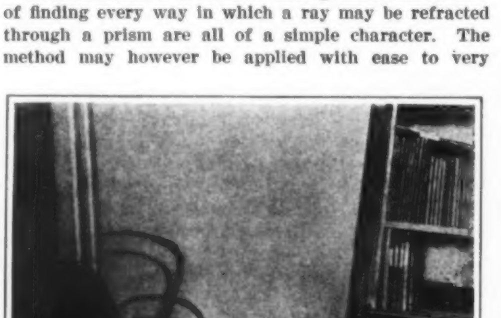


Fig. 18

complex and unsymmetrical prisms, and to cases in which several prisms have to be used in combination in order to avoid chromatic dispersion.

Owing to the brightness of many of the ghost images they can be photographed without difficulty. Fig. 16 shows a bookcase, desk and two pipes against a cream colored wall which were selected as a subject for this purpose. Fig. 17 shows a photograph taken through an ordinary right angled prism which was placed in front of the lens, the camera having been turned approximately through a right angle. The main image (transposed left and right) is formed as in Fig. 7, and superposed on this is a ghost of the bookcase and the attached diagrams formed as shown in Fig. 8. The difference in brightness of the two ends of the photograph is due to the limit of total reflexion being passed within the region included in the photograph. Fig. 18 shows a ghost image with the pentagonal prism illustrated in Fig. 10. The chairs and bookcase belong to the proper image, and the horizontally inverted desk and pipes are ghost images. Fig. 19 shows a ghost taken through a 60° constant deviation prism shaped like half an equiangular triangular prism. The glass of the prism was full of striae, which have affected the ghost much more than the erect image.

The last photograph, Fig. 20, is somewhat remarkable because it shows a ghost the presence of which might not have been anticipated, and which is hardly likely to have an opportunity of showing itself in a complete optical instrument. It is taken through a roof prism with the edge of the roof horizontal and on the left of an observer focussing the image on the ground glass. The camera is pointed at the fireplace which is about 120° to the left of the actual desk as seen from the camera. The bookcase, desk and pipes show up strong-

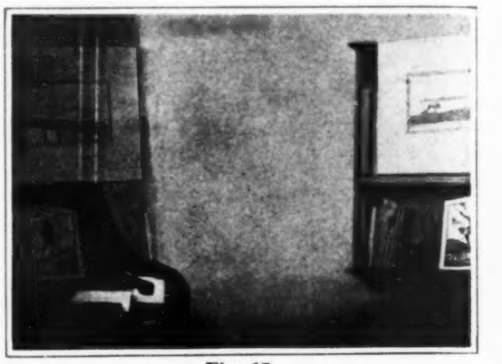


Fig. 17

ly in a ghost image formed by light which is incident on the front end of the prism at a very small angle (almost grazing incidence). The curved bright line which crosses the figure horizontally is another ghost—the image of a straight object. The fact that it is curved shows that it is not achromatic. The curvature of such an image is often the readiest indication that the equivalent block of glass so far as this image is concerned has not parallel faces. Very frequently the colored edges of the image cannot be seen although curvature is decidedly pronounced.

In taking these photographs the prisms were carefully arranged in closely fitting dead black mounts which prevented any light entering the prism except through the one surface selected as the incident face. The mounts were extended to cover the lens also, so that all light entering the camera had previously passed through the prism. These precautions are essential if spurious ghosts are to be avoided.

*Transactions of the Optical Society, London.

Mortality Due to Snakes and Wild Animals in India

Snake bite caused the death of 23,918 persons in British India in 1917, an increase of nearly 300 over the figures for 1916. However, the number of snakes destroyed increased from 65,765 to 73,968, for the killing of which bounties to the value of $1,045 were paid.

There were 2,176 persons killed by wild animals in 1917, 102 less than in 1916. Tigers were responsible for 1,009 deaths, leopards for 339, wolves and bears for 280, and elephants and hyenas for 89. Of the 459 deaths caused by "other animals," 89 are assigned to pig and 199 to crocodiles or alligators. During the year 19,476 wild animals were destroyed, for which rewards amounting to $54,161 were paid by the Government. Among the 19,476 wild animals destroyed, 1,295 were tigers, 6,037 leopards, 2,784 bears, and 2,147 wolves.—*Commerce Reports No. 302.*

Sulphate of Copper Process

A recent European patent relates to the production of sulphate of copper, starting with sulphide of copper as a base. The process consists in dividing up the copper sulphide by the addition of an inert substance such as sand, for instance, then the mixture is exposed to the action of an oxydizing atmosphere, it being heated at the same time. In this way the sulphide is oxydized to sulphate by the addition of oxygen, and the effect takes place under the best conditions.

Conservation of Men on Our Railroads*

A ROAD engineer's responsibilities and duties are less varied than those of a conductor, but they are more intensive and continuous. His preparatory work is merely to inspect his engine and to see that it is supplied with fuel, water, oil, and other necessaries for the run; and his clerical work is limited to making out a time slip for himself and his fireman, and to reporting engine defects and failures. But from the time he takes the throttle at least six things constantly weigh upon his mind—his train orders, the automatic block and manual signals along the line, the track immediately in front, the water gauge, the steam gauge, and the sound of his engine. Even a moment's inattentiveness to any of these things may mean delay or disaster. In time the constant observance of these essentials becomes almost automatic and subconscious; but the general testimony of engineers is that the sense of responsibility and of latent danger always remains. In bad weather, when soft tracks and possible washouts or slides are to be watched for, or when blizzards sweep the prairies, burying landmarks and blinding the outlook until only the jarring of the drivers on the frogs tells the engineer that a station has been reached, the strain of this responsibility rises to a maximum even with the most experienced. Moreover a careful engineer does more than run his locomotive according to orders and keep it in condition upon the road. When rounding curves he looks back for hot boxes, he senses in the movement of the slack the development of equipment defects in the cars behind, and in general he cooperates with the caboose crew to maintain the smooth mechanical operation of the entire train, and is held equally responsible with the conductor for its safety.

An engineer's physical labor, however, is much less arduous than that of a locomotive fireman. The latter is in this respect the hardest worked man in train service. His direct responsibility is comparatively light, though he must watch signals from the left side of the cab and must read and understand train orders. A very few large locomotives of recent construction have mechanical strokers, but they form an inappreciable fraction of the motive power in use on American railways. A considerably larger part of the engines running in the Southwest and on the Pacific coast burn oil fuel, and in such cases the physical labor of the fireman is comparatively light. In suburban and mountain service, especially where there are long tunnels, electric power—which is cleanest and easiest of all for the engine crew—is being introduced; but this change is still in its infancy. Therefore the typical fireman is a coal shoveler. The amount of coal he must put into the fire box in a given time varies with the size and construction of the locomotive, the class of service in which it is engaged, the weight and speed of the train, the quality of fuel, the grade of the road, weather conditions, and other factors, among which must be reckoned the skill of the fireman himself.

Taking the average of all locomotives upon a representative American railway in 1916, every switch engine burned 135 pounds of coal for each mile it ran, each passenger engine 105 pounds, and each freight engine 229 pounds. In covering a division of 100 miles the fireman of a freight locomotive would have to shovel more than 11 tons of coal through a low firebox door, stooping and swinging well back to spread the fuel or to place it on thin places in the fire, and opening and closing the door for every scoopful. He performs this labor standing on the unsteady deck of a locomotive, where an inexperienced man might have difficulty in balancing himself without support. Among other duties of a physical character he must wet down the coal, break up the large lumps, pull the coal forward from the back of the tank or tender box—which sometimes amounts to double handling nearly half the fuel burned—shake the grates, and if the coal clinkers badly he must sometimes clean his fires in the course of the run. He takes on coal and water, attends to other engine supplies, watches the steam gauge and the road signals on his side of the cab, and assists the engineer in minor phases of engine operation.

Besides being laborious these duties are sometimes attended by severe physical hardships. The heat thrown out by the fire boxes of the extremely large locomotives now coming into use is intense, especially when a long freight is barely moving up a heavy grade, devouring fuel as fast as it can be piled upon the fire, and making practically no breeze through the cab by its own motion. Firemen on runs of this kind sometimes have to protect themselves with leather aprons to keep the heat from igniting their clothing. When we add to these conditions an outside temperature of 100 degrees or more, such as not infrequently occurs in the southern and prairie states during the summer, a situation is reached that taxes the limits of physical endurance. At such times heat prostrations become frequent—as railway men say, the firemen "burn out" or "the monkeys get them." They suffer undue strain when a badly clinkered fire has to be cleaned in the middle of a heavy run, for this is rated exceptionally exhausting labor. Firemen are also exposed to more or less suffering from smoke and from gases thrown back from the fire box in passing through long tunnels or snowsheds, especially where more than one locomotive is attached to a train. They sometimes lose consciousness and even die under these conditions.

*From a report of the Eight-Hour Commission investigating railroad conditions.

Fig. 19

Fig. 20

It is a matter of controversy between railway employers and firemen whether the labors and hardships of the latter are increasing or diminishing. On the one hand, much larger engines are now employed than formerly, and the tonnage of trains is constantly growing—two conditions that add to a fireman's burdens. On the other hand, important mechanical improvements have lightened the work of stoking, and the Brotherhood of Locomotive Firemen and Engineers has secured new working rules in its schedules with many companies that relieve its members of some of their former labor. Such rules are those providing that men shall be stationed at intermediate points on a division to clean fires, or to pull down coal to the front of the tender tank, and that helper relay firemen shall be furnished on exceptionally long or difficult runs. However, new mechanical devices have contributed more than these rules to alleviating the fireman's condition. Oil-burning locomotives have made possible firing heavy trains through the southwestern deserts, where the mercury reaches 120 degrees or more in the shade and the temperature of the breezes through the cab window almost rivals the blast from the fire-box door. Brick arches and superheaters, by causing the gases in the fire box to be consumed more completely, and by utilizing a larger fraction of the heat generated for steam production, have lessened the amount of fuel employed to pull a given weight of train. Fire grates are now shaken by power, and air doors enable the firemen, by a mere pressure of his foot, to throw open the fire box to admit coal, where formerly he had to stoop over and pull the door open by a chain. Coal pullers automatically shift the coal forward in the tender tank to a point within reach of the fireman. Mechanical stokers feed the coal from the tender into the fire by a conveyor and blast contrivance, so that the fireman's stoking duties are reduced largely to attendance upon machinery.

An analysis of work performed by locomotive firemen in slow-freight service during four runs with hand-stoked and mechanical-stoked engines, respectively, affords the following illustrative data: The four hand-stoked locomotives ran an average of 79 miles, pulling trains having an average weight of 3,149 tons, and the firemen were on duty an average of 14 hours and 9 minutes. Of this time they spent 7 hours and 3 minutes in actual manual labor, of which 4 hours and 59 minutes, or more than one-third of the time they were on duty, was devoted to shoveling coal into the fire box. Most of the remaining time used in manual labor was employed in hooking and scraping fires, shaking grates, breaking up large lumps of coal, shoveling down coal from the rear of the tender, and cleaning fires. Each fireman handled with the scoop—directly into the fire box—about 11 1/5 tons of coal. The time not employed in manual work included rest intervals while running and station work and watching signals.

Similar figures for the four locomotives having mechanical stokers are: Average distance traveled 115 miles; average weight of train hauled, 2,135 tons; time on duty, 13 hours and 10 minutes; time devoted to actual manual labor, 4 hours and 5 minutes, or 19 per cent. less of the time on duty than in case of hand-stoked engines; time employed shoveling coal by hand into the fire box, 1 hour and 24 minutes, or nearly 25 per cent. less of time on duty than in case of hand-stoked engines; amount of coal burned, 22½ tons, of which about 2½ tons were fired by hand.

Some objection is still made to mechanical stokers, though they are rapidly being improved. Those of an older type are noisy and dirty, keeping the cab full of flying coal dust. They are a recent invention, the number in use having risen from 6 of all designs in 1910 to 1,418 in 1916. Even the latter number would not supply the road service of one of our larger railway systems.

Firemen occasionally receive assistance from the engineer and the head brakeman. The latter may shovel down coal from the rear of the tender—though this is forbidden by union rules on some roads—or even fire the engine for a short period, especially in exceptionally hot weather when the fireman shows signs of playing out. He also lights signal lamps and performs other minor services around the engine as a matter of accommodation. Engineers sometimes assist in cleaning fires; indeed, one case was observed where both members of the engine crew and two members of the train crew, including the conductor, were engaged in this operation. Likewise in very hot weather an engineer will put an exhausted fireman at the throttle for a few minutes and fire the locomotive himself. But all these interchanges of service are voluntary, and are more or less the exception. They are looked upon with disfavor by union officials, as tending to create precedents that may be used oppressively by operating officers.

A fair summary of the present situation of locomotive firemen would seem to be that their duties are passing through a transitional phase, where exceptional labor and hardships are imposed in some instances, but where the promises exists not only of remedying these but of making the general condition of this branch of service better than before. The brotherhoods have thrown their influence toward mechanical improvements, in some instances making the adoption of labor-saving devices within a stated time an article of their agreement with employers. Some of these improvements, such as the brick arch and superheaters, are intended primarily to save fuel, which is a most important matter with railway managers. Exceptional hardship is just now imposed on firemen where train tonnage has been increased and large engines have been introduced without these improvements, where double-heading has become the rule not only on grades but over an entire division, and where the recent coal shortage has forced the adoption of inferior fuel, that increases the labor of shoveling and clinkers the grates so that fires demand frequent cleaning. The deterioration of motive power during the late railroad depression, and the subsequent period of excessive traffic and shortage of skilled mechanics, has also added to the labor of both firemen and engineers.

Photo-chemical Reactions in Photography

THE author has previously shown that all organic substances are decomposed by light of the wave-length which they absorb; colorless transparent substances are decomposed by ultra-violet light, or, if they are stable to daylight, by radiation of still shorter wave length ("outer" ultra-violet). It is now suggested that the light-sensitiveness of photographic materials is due chiefly to the organic carrying medium of the silver salt (albumin, gelatin, collodion) rather than to the silver salt itself. The absorption spectra of dialyzed albumin, 10 per cent gelatin solution, and collodion solution to ultra-violet and outer ultra-violet are given; with the two latter absorption is from about 350 $\mu\mu$ upwards and with albumin from 300 $\mu\mu$. The spectra for potassium bromide and silver nitrate solutions are also given, the absorption being negligible. The author suggests also, in analogy with the increase in light-sensitiveness of albumins by dyeing, that in the color-sensitizing of photographic plates it is the relationship between the dye and the medium which is important.—*Note in J. Soc. Chem. Ind. on an article by F. Schanz, in Z. wiss. Phot.*

Notes on Kite Flying*

For Meteorological Observations

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THE following notes and suggestions on kite flying are a digest of field experience in Nebraska and North Dakota, principally the former State, and are written with the object of being helpful to inexperienced men, and giving them some source of reference that may be of service in solving the many perplexities that constantly arise. The deductions arrived at from a day-to-day comparison of the upper-air records with the weather map have entered into these notes, and consequently an occasional allusion to problems in meterology has been unavoidable. Many of the following statements that bear on the relation of kite flying to weather conditions are therefore open to amendment when applied to other portions of the country than the Middle West. However, as the present projected sites for the new aerological stations all lie in the general eastward drift, it is thought that there will be enough similarity in the features of weather conditions encountered in kite flying to call for common general rules.

It is the intention here to give the observer such advice as will enable him to obtain the highest possible flights consistent with safety under various weather conditions. Practical details have therefore been almost entirely omitted, as these are amply covered by instructions already in effect. In this connection it should be remarked that continuity of daily flights is just as important as high flights, and all the competency of the observer derived from experience and study should be directed toward both ends.

As it is not likely that telegraphic cipher reports or synoptic weather maps less than 24 hours' old will be available for the use of the new aerological stations, it is incumbent upon the observer to study diligently the record of local weather conditions—principally the barograph and the clouds, the kite records, and the weather maps that are received, and to correlate these with the view of ultimately being able to anticipate to some extent upper-air conditions from local indications alone. It is well to follow the progress of the barograph from day to day, and thus try to grasp the sequence of HIGHS and LOWS, and their approximate relation to the station.

Accuracy of record and good judgment in observation are essential to a logical interpretation of the kite records. Opportunities for observations leading to important deductions in meterology occur frequently in kite flying, apart from those that make a part of the routine record. Initiative and alertness in work and observation are therefore a valuable asset in the field.

Discrimination should be used in those instances in kite flying that permit latitude of opinion. An example is the case of determining the direction of the wind aloft. This should be ascertained not only by observing the apparent direction of the head kite from the observer and the other kites, but also by the position of the kite in the theodolite (assuming that the head kite flies straight), and by whatever horizontal movement it may have. The observer should familiarize himself with the appearance of the kite in the theodolite at close range, in order that he may, when necessary, associate an angular appearance of the kite in the theodolite with direction of the wind in which it is flying. When the kites make a large "swing" during flights, a careful comparison of the recorded apparent directions aloft when reeling out, with the apparent directions at corresponding altitudes when reeling in, will to a large extent eliminate the possibility of error. As it is often difficult to determine actual directions of the wind aloft at night and when the kites are obscured by clouds, experience should be directed toward observing the relation between the azimuth of the wire as it leaves the reel and the direction aloft.

Kite wire.—As safe kite flying is so largely dependent on the condition of the steel piano wire used, utmost vigilance should be observed to prevent injury to it and detect any evidence of weakness throughout its length. Too much emphasis cannot be laid on the importance of always keeping the wire taut. After being repeatedly wound and unwound about the reel drum and pulleys, and particularly if the wire has been run under tension over wheels of too small diameter, or has rubbed against some solid object, such as the side of the reel house, a fence post, or tree, internal strains are developed that will cause the wire to coil as soon as it is slackened. If on again tightening a single ring becomes a kink, a breakaway beyond the kink is inevitable. The tendency to coil varies inversely as the diameter of the wire, and it is therefore advisable to feel out the smaller sizes of wire frequently when reeling in or out.

Opportunities for the wire to slacken sufficiently to coil are always present when flying in light winds; and when under such conditions, it becomes necessary to reel in rapidly to assist in raising the kites, the reel should always be slowed down gradually before coming to a stop, if conditions permit. Rapid reeling out in a light wind, especially when pronounced convection currents are present, will often cause coiling and probably kinking of the wire. With a wind barely strong enough to sustain the kites in the air, and convection currents prevailing, a wave-like effect is often observed, the kites rising and falling in succession. Then, if wire is played out rapidly to the rising kite, the wire between it and the falling kite immediately in advance will slacken and probably coil.

Another common source of damage to the wire arises from faulty wrapping of the heavy wire[1] used to attach secondary kites, and the injuries incident thereto. Under the direction of an experienced man, a novice should learn how to attach this wire without leaving permanent sharp bends in the piano wire. Occasionally this branch wire should be shifted a few meters[2] from its usual position on the piano wire. When, after landing a secondary kite, it is found that the cord is wrapped around the piano wire, care should be taken not to pull the cord too hard in the attempt to unwrap it, as this causes an injurious twisting strain on the wire. In an emergency, it is better to cut the cord than to try to unwrap it hurriedly.

The wire should be kept clean and slightly oiled. Incrustations of ice or frost should be wiped off when reeling in, and the wire again wiped with a piece of oiled waste when reeling out in the next flight. This wiping of the wire should be frequent; it not only serves to keep the wire from rusting, but prevents kinks passing by unnoticed. But few breakaways are caused by the pull exceeding the normal tensile strength of clean undamaged wire. Kinks, sharp bends, rust spots, or flaws in the splices cause the majority of accidents.

When to reel in.—The observer should memorize the value of the sines on angles commonly recorded with the theodolite, thereby enabling him to compute quickly approximate altitudes when necessary and to keep constantly in mind the relation between the altitude of the head kite and the amount of wire out. So long as the head kite maintains a fairly steep angle, say 30° or more, it may be assumed that the pull is at its maximum and that, barring a change in the weather conditions, reeling in will not throw the kites much higher nor materially increase the pull. Such a flight may be considered a normal one, and the number of kites to use and the distance to reel out will be clearly indicated by the dynamometer.[3]

Ordinarily the final reeling in should commence when the stationary pull shows indications of passing 200 pounds. Also, more kites should not be launched after the dynamometer reads between 150 pounds and 180 pounds, depending on the number of kites already flying. A little computation will generally settle this point. For example, when the pull is 150 pounds, with two kites, another kite is likely to increase the pull to 225 pounds; while a pull of 175 pounds, with seven kites, will probably not be increased to more than 200 pounds by the addition of another. The same line of reasoning should be used when estimating the effect on the pull of reeling in or a probable increase in wind. Given a certain pull, it is obvious that reeling in or an increase in wind velocity will augment that pull in proportion to the number of kites used. It should further be kept in mind that the tensile strength of the steel wire varies from about 260 pounds for the 0.032-inch size to about 400 pounds for the 0.044-inch size, and that the wire should be taxed to little more than half its normal capacity.

Judgment in the matter of the number of kites to use should also be influenced by the possibility of the kites ascending into a decidedly stronger wind aloft with further reeling out. The winds, of course, normally increase with altitude, but occasionally the wind gradient may be so much steeper than is ordinarily experienced as to upset calculations unless foreseen. Neglecting the increase usually found in the first few hundred meters above the ground, we may usually expect to find rapid increases of wind velocity with altitude between 1,000 and 2,000 meters above the surface. Indications of an abnormal increase with altitude will be apparent to the careful observer by the action of the dynamometer, but more especially by the tendency of the head kite to maintain or even increase its angle when reeling out.

The preceding suggestions suffice for all flights where, as already mentioned, the kites maintain a good angle. If, however, there is much wire out with many kites and the angle is low, success and safety will necessitate a rather tedious program of work. It is obvious that reeling in under such circumstances might raise all or most of the kites to such higher altitudes and stronger winds as to increase the pull to the danger point. It will then be necessary occasionally to sound the strength of the upper winds by reeling in a few hundred meters before putting on additional kites, meanwhile watching the head kite through the theodolite. If the temporary reeling in is not successful in permanently raising the kits, a note should be made, mental or otherwise, of the depth of the light wind. It will eventually resolve itself into a matter of judgment as to whether to reel in all the kites and rearrange them with a view to greater lifting surface by using more or larger kites or to continue the flight with the expectation of finally lifting them into sufficiently strong winds aloft.

After an altitude of between 2,500 and 3,000 meters has been sounded without indications of strong wind it is probable that no dangerous wind will be encountered to an indefinite height. This statement has a rather general application. When an altitude of about 3,000 meters has been reached, with only a moderate pull and a good angle, experience has shown that still higher altitudes may generally be obtained by adding more kites and reeling out farther, without materially increasing the pull. This may be explained by the tendency of light winds to extend to very high altitudes. Furthermore, actual increase of velocity with elevation is offset by the diminishing air density.

The circumstance of kites flying at a low angle is often associated with a stratified condition of the air, manifested by a brisk shallow wind, on top of which the kites seem to float as though on a liquid surface, seemingly in a calm and all flying at about the same altitude. This condition may be met with in winds from any direction and except in easterly winds (for reasons explained later) requires the exercise of caution lest too many kites be launched and exposed to the danger of a rise into winds too strong for the capacity of the wire. The danger is proportional to the proximity of the lower wind to a westerly direction, being practically zero in easterly winds and at a maximum in winds between northwest and southwest. When kites rise above such a calm stratum they will ordinarily enter a westerly wind and will cause a pull at the reel that will be partially a resultant of the direction and amount of the pulls of the individual kites.

There is also indication that the less the winds change in direction with altitude the greater will be their average velocity, which is simply further evidence of the general greater strength of westerly winds.

Kites floating above a shallow wind, other than easterly, can generally be reeled up into higher winds aloft after four or five kites have been launched on a few thousand meters of wire. With easterly winds, however, the change in direction is often so abrupt, and of such angular magnitude in comparatively short intervals of altitude, that repeated reeling in will be useless. In such a case the final ascent of the leading kites into stronger upper winds can often be accomplished by exercising patience. When, after a few attempts, it becomes apparent that reeling in is futile, it will be necessary simply to await the automatic rising of the kites that sometimes follows a wide change in azimuth. This horrizontal shifting of the kites is generally to the right and very slow and will not result in raising the kites until the upper portion of the wire is approximately in line with the observed drift of the higher clouds. The total change in angle from

*Monthly Weather Review, Supplement No. 13.

[1]No. 9 or No. 10 galvanized iron telegraph wire is used for this purpose. It is usually about 1⅓ meters in length, and has a loop in which is tied a cord, the other end of which is fastened to the secondary kite.—W. R. G.

[2]Ordinarily the secondary kites are attached at more or less regular intervals from the head kite, *e. g.*, 500, 1,200, 2,000 meters, etc. Thus, there is a possibility of weakening the kite wire by repeated wrappings of the "splice" or galvanized-iron wire at the same place.—W. R. G.

[3]A dynamometer on each kite reel indicates at all times the "pull" on the wire.—W. R. G.

the surface wind to the direction of the highest kite may be as much as 200 degrees.

It will generally be found that the "floating" type of kite flight is associated with abrupt, though not necessarily large, changes in wind direction with altitude. Exceptions occur and may be explained from the evidence of the meteorograph records as due to other abrupt changes in the meteorological elements causing air stratification.

Veering of winds with altitude averages greater than backing, both in frequency and angle, and is characteristic of approaching LOWS and retreating HIGHS, although more pronounced in the former. Backing of winds, associated with retreating LOWS and approaching HIGHS, is a more gradual process and is sometimes preceded by veering in the lower levels.[4] From what has been said the amount of shifting in wind direction with altitude, being significant of the probable average velocity, has an important bearing on the number and size of kites that can safely or advantageously be used. The accuracy with which this disposition of the winds can be foreseen will depend largely on the care with which observations of cloud direction and velocity are made.

Easterly winds as a rule occasion no anxiety to the observer from the standpoint of excessive pull unless complicated by heavy rapidly moving clouds. Deep east winds are nearly always light to some unknown limit; and when strong easterly winds occur they either diminish with altitude or are rather uniformly strong with altitude, in which case the number of kites to use is easily apparent. The condition of light easterly winds surmounted by strong easterly winds is probably rare. While in the case of kites swinging from lower easterly winds to upper westerlies a strong current from the latter direction may be encountered for reasons already given, the pull will likely not be excessive.

A few flights will convince the observer to what extent success in kite flying is measured by ability to anticipate conditions in altitude and changes with time. considerations of pressure rank first in making deductions of probable upper-air conditions and should be judged somewhat as follows: the state of the barometer, whether rising, falling, or stationary, and whether above or below normal; the duration and magnitude of the rise or fall; and the probable geographic distribution of pressure.

Changes in the surface wind are inclined to be synchronous with changes in pressure and the velocities themselves proportional to the pressure gradient. This relation between surface pressure and wind is not so simple when applied to velocities aloft. It will often be found that surface winds alone fail as an index to the probable velocities aloft and that they should be considered in connection with the previous few hours' pressure record. For reasons that will be evident from what follows it will often be necessary to wait until the first kite has ascended a few hundred meters before coming to a final decision as to what conditions to expect.

A condition that is pronounced, and that repeats itself with great similitude, is that which accompanies a period of rising pressure when the latter is already above normal. During the period of rising pressure strong winds increasing with altitude seem to be the rule, while the least indication of flattening out on the barograph trace is almost certain to be followed by diminishing winds—near the ground first, and progressively later at higher altitudes. The depth to which the strong winds will extend varies as the magnitude of the HIGH, and in the case of shallow HIGHS it may be possible to break through the stratum of strong wind into weaker winds aloft, provided the winds near the surface are not severe enough to beat down the kites. While without the aid of weather maps it will not ordinarily be possible to estimate the magnitude of the approaching area of high pressure, a knowledge of these facts will nevertheless be helpful. If a flight has been started while the pressure is rising steadily and the pull soon reaches the limit of safety, it will sometimes be found profitable to apply the brake and wait, an hour or more if necessary, until the expected stable pressure, with its attendant abatement of winds, makes further reeling out possible. The higher the pressure the more likelihood there is that it will soon reach its crest.

After the pressure has become high and stationary, the winds will be light to moderate to some considerable altitude, their average strength depending on the magnitude of the HIGH and the position of its crest. The surface wind may then be too light to launch a kite until the pressure has begun its downward trend. Occasionally, though, a temporary interruption of the stationary pressure may strengthen the surface wind sufficiently to start a flight—a circumstance the observer should be on the alert to take advantage of.

If a flight has been started after a more or less continuous fall in pressure sets in, increasing winds may be expected during the progress of the flight. The velocity to which the winds will rise in any given time will depend not only on the rate of fall in pressure, but in a sense, also, inversely as the height of the barometer. In other words, it will generally be found that the greater the magnitude of the retreating HIGH the longer (in terms of hours) will the intensity of the on-coming LOW be delayed. On the other hand, a slowly moving HIGH, even though it be comparatively flat, appears effectively to delay the advance circulation of a following LOW. Shallow winds, above which it is difficult to raise the kites unless much lifting surface is used, are common in the rear of HIGHS.

If the barometer is low and stationary, the surface winds may be light, and under such circumstances one should resist the temptation to use large and many kites until the preceding fall in pressure has been looked into. If the fall has been slow and no very low level reached, this, together with the light surface winds, may be construed as indicating comparatively light winds to a great depth. If the barometer is quite low and the preceding fall has been rapid, a more or less sudden rise in velocity is probable at some altitude that may be as low as 200 meters above the ground.

If a flight is made during a period of rapidly falling pressure that is below the normal, the winds will no doubt be very strong from practically the ground up; in which case, if a flight is at all possible, it will naturally be limited to few kites. Ordinarily, strong winds do not preclude the possibility of a flight unless they attain gale force near the ground. Where the strength of the wind limits the number of kites to three or less, flights to nearly 3,000 meters above the ground may be obtained by rapid reeling out, and without risk of increasing pull on the reel-in, owing to the beating down of the kites as soon as the reel is stopped. In such a case care should be taken not to reel out more wire than the kites can hold above the ground, bearing in mind the fact that the wire will fall as soon as reeling in commences.

When the barometer is low and rising, the winds are likely to be more uniform in direction and velocity with altitude, and less given to abrupt changes, than when the pressure is low and falling. Much the same precautions should be observed in either phase of low pressure, although in the case of rising pressure there is less probability of the pull increasing after the highest possible altitude has been attained, the supposition being that the winds have already reached their maximum. On the whole, it may be said that falling pressure presents more difficulties than rising pressure. Low barometer, owing to the complexities of cyclonic circulation, has more elements of danger than high barometer.

While the different conditions of pressure met with from day to day are of course endless, their relation to the probable velocities may be summed up as depending on the barometric tendency, and the position of the centers of high and low pressure areas. The latter qualifying circumstance will be the most uncertain to make deductions from in the absence of weather maps, but a good deal can be accomplished by careful observation and study. In particular should study be directed toward determining the probable direction of a nearby center of low pressure. When the direction of movement of a LOW coincides with the direction of the gradient winds (with respect to the surface isobars), there is evidence that winds at the various altitudes average strongest, other things being equal, and that when such a position is impending the rise in velocities will be most rapid. The trend of the isobars can be closely estimated from the surface winds, the barograph trace, and the aspect of the first kite launched after it is a few hundred meters high.

In estimating the probable direction of the centers of high and low pressure from the station at the beginning of a flight, the observer should amplify his knowledge of the general laws of surface circulation with observation of the wind direction a few hundred meters above the ground. Unless surface winds are quite strong and have blown from a certain direction for some time they do not give conclusive evidence of the direction of the pressure gradient, owing to the susceptibility of light winds to local topography and diurnal change in temperature. Judgment will therefore often have to be deferred until the behavior of the first kite has been observed.

With a little practice, conclusions concerning the pressure distribution can be arrived at agreeing quite closely with that subsequently shown on the weather map. This refers more particularly to the cold season, when pressure conditions and changes are sharply defined. With approaching warm weather the whole problem of analyzing pressure conditions becomes increasingly difficult, and one will often be at a loss to know what to expect. This has its compensations, however, in the comparative freedom from unsafe conditions (except such as are of a local nature) in summer weather.

The trend of the isobars can be approximated by considering the direction of the wind at that moderate altitude above the ground where surface friction is surmounted and to which the kites gradually veer. Abrupt changes in wind direction have causes other than surface friction. In LOWS and in the rear of HIGHS gradient winds will be found at only a few hundred meters above the ground. While their direction with reference to the isobars varies somewhat with the rate of movement of the LOW or HIGH and their depth varies enormously in different quadrants, it is sufficient to know that the direction of these gradient winds is approximately parallel to the surface isobars, with low pressure on the left. Above these gradient directions the winds in a low will ordinarily veer or back to the higher levels in which the LOW seems to move, depending on whether the LOW is approaching or receding. In the front of a pronounced HIGH the winds will often back from the ground up, no veering being apparent at any level.

In comparing conditions in high and low latitudes it may be justifiable to liken them somewhat to conditions in winter and summer, respectively, and therefore to qualify most of the foregoing remarks in applying them to low latitudes in much the same manner as has already been done with respect to summer conditions. Perhaps all that has been said with respect to HIGHS will need revision for southern and southeastern States, where HIGHS are inclined to stagnate. With respect to LOWS, however, it is thought one needs to consider only their different average courses in those sections.

Low-lying dense clouds add to the perplexities of kite flying, as they are liable to be a menace in almost any condition of low pressure, in any wind direction, and at any season of the year. St. clouds, however, are characteristic as trouble breeders, and any indication of St. Cu. blending into St. should be reason for caution; and, conversely, St. breaking into St. Cu., should be considered encouraging. In warm weather dense St. are not necessarily dangerous unless they are moving rapidly and rain is falling or seems imminent. The combined effect of rain and wind often completely crushes one or two kites. It will sometimes tax the initiative of the observer when caught in such conditions to limit the danger to one or two kites and avoid excessive pull on the wire. If a flight is started during the prevalence of such conditions, reeling out and the launching of kites should proceed cautiously until the absence of any strong wind in the cloud layer is assured.

In the cold season of northern latitudes an additional danger attached to heavy clouds lies in the accumulations of ice or frost on the kites and wire in amounts that may be sufficient to cause them to fall in spite of fastest reeling in. This danger is present only when the surface temperature is in the neighborhood of freezing or somewhat below. When low clouds prevail with this state of temperature, a certain amount of ice will almost always form on the wire; but excessive deposits on wire and kites will occur only when the sky is overcast or nearly so and the circumstances favor a prolonged exposure to the clouds. The deposit is caused by the minute globules of subcooled water, sometimes having a temperature as low as —10° C., freezin on contact with the solid surfaces—a process that is facilitated by wind. There is very little danger of more than a light coating of ice on the wire when snow is falling freely, but moist snow with wind may cause an excessive pull in the same manner as rain with wind.

If, after rising above a strong surface wind, the kites float on top of or in the clouds, this fact will be indicated by the dynamometer. With freezing temperature, unless the kites can be thrown up higher by reeling in, accumulation of ice will proceed over a long approximately horizontal line of kites and wire and cause them gradually to settle down. It is probable that such a comparative calm is incidental to the upper surface of the clouds and that a successful lifting of the kites will free them and most of the wire from the influence of the clouds. If the dynamometer indicates that the kites are flying at a good angle, a condition of great cloud depth may be present, the possible consequence of which will be indicated only by a lowering in the angle of the wire and a lessening of whatever atmospheric electric potential might have previously

[4]For more detailed discussion of this subject see Bulletin of the Mount Weather Observatory, vol. 6, part 4, p. 125 et seq., and Monthly Weather Review, January, 1918, pp. 20-21.—W. R. G.

been recorded. A normal potential will dwindle almost to nothing as the wire becomes increasingly bulky with ice or frost and lower in angle. Dynamometer readings can be relied upon only to indicate the approximate angle of the kites before they and the wire have had time to become heavily coated, after which the pull is inclined to be deceptive, owing to their increased weight enabling the kites to present more nearly a normal surface to the wind.

When in the judgment of the observer ice conditions seem imminent, it is good policy to reel out as fast as consistent with a good ascensional rate of the kites, thereby penetrating the cloud layer with minimum exposure thereto. A good rule to observe in any threatening cloud condition is to begin the final reeling in well on the safe side of 200 pounds in order to leave a margin of safety for any possible increase in pull later on.

The circumstance of ice incrustations on the wire, which have been observed as much as a half inch in diameter,[5] together with the fact that it is most pronounced when snow is not actually falling, would seem to indicate the absence of some final stage necessary for precipitation, when all the other essentials for condensation are present. An interesting commentary on this point is afforded by a flight made at Drexel in the early spring of 1917. Reeling in, necessitated by heavily ice-laden kites and wire, had proceeded only a few hundred meters when a flash of lightning or sudden overcharge ruined the entire length of wire out from the reel,[6] a considerable portion of the upper end having apparently been completely burnt. The significant fact is that notwithstanding the heavy deposit of ice on the wire and kites precipitation was delayed until about or shortly after the accident, which was soon followed by a vigorous thunderstorm, accompanied by sleet and soft snow.

As thunderstorms are so much a local phenomenon, no general rules can be laid down for detecting their approach. No precaution seems ordinarily of avail other than listening attentively for thunder on days when conditions seem to favor thunderstorm development and frequently breaking the electrostatic ground for evidence of "flash" discharges. By "flash" discharge is meant a momentary mounting of the potential that causes intermittent sparks at the ground gap, or sparks that may even jump the air space in the voltmeter and are synchronous with discharges of lightning in the vicinity. As such irregular charges may be an accompaniment of storms passing the station as well as of one approaching it, they are not in the majority of cases a warning of unsafe conditions. Lightning flashes on the horizon should be considered in connection with the observed drift at the probable altitude of such clouds as are visible. The probable course of the outlying storm may thus be arrived at.

A possible indication of thunderstorm development may be inferred from the strong vertical currents of great depth that are frequently evident in warm weather from the behavior of the kites. If associated with high surface humidity and increasing Cu. or St. Cu. cloud conditions are probably ripe for thunderstorm formation.

Flights have on a number of occasions been caught in thunderstorms, and while the resulting records were extremely interesting the danger of personal injury and damage to equipment is too great to justify other than unavoidable flights in such instances.

The continuity of daily flights will depend a great deal on the vigilance and energy of the station force, as on many days when comparative calm prevails a brief interval of breeze will be sufficient to carry the kites into steady sustaining winds aloft.

Although the average surface velocities are greater in daytime than at night, this fact, particularly in warm weather, has often the opposite significance in kite flying. This is explained by the fact that convection currents, even though they may cause a slight acceleration of surface movement, have a damping influence on the normal increase of wind velocity with altitude and are, moreover, a mechanical hindrance to successful launching of kites. As already mentioned, they have a tendency alternately to depress and elevate the kites, which in the case of secondary kites may be so prone to cause continual confusion of the kites, cords, and wire as to threaten their fall and necessitate reeling in. Flights should therefore be started early enough on summer mornings to assure a thousand meters or more in altitude before convection currents are well under way.

Sometimes on clear, quiet days, during which a flight has been impossible, the kites will readily go up about sunset, or when nocturnal cooling sets in. It completes the often observed paradox, just mentioned, of flying conditions and surface wind, as in such instances the station anemometer is very likely to record lower velocities than at any time during the day. A plausible explanation is that the sudden cessation of convection currents permits the normal tendency for horizontal air movement to come into play and that the intense radiation at that hour confines the stagnant air to those very lowest layers immediately above the ground. At Drexel this was frequently observed and taken advantage of, where it was, moreover, found to be somewhat peculiar to south winds.[7]

The foregoing paragraph illustrates one of the many causes that operate to mask the possibility of a flight from indications of the station anemometer. Notwithstanding that it requires at least 5 m.p.s. to balance a kite and several hundred meters of wire, velocities as low as 1.5 m.p.s. appearing on the register need be no discouragement to attempting a flight.

Much of the text of these notes is not directly related to practical kite flying but has been written rather with the idea of promoting the interest of the observer. While a profound knowledge of meteorology is not necessary to practical kite flying, it must be admitted that the greatest justification for upper-air investigations will come from those stations where the interest of the men is aroused in the results as well as in the performance of their work.

Experience in kite flying will be valuable in the measure that it develops not only prescience of danger, but confidence in action when doubtful conditions obtain. Overcautiousness may spoil or curtail many a flight that would otherwise have been safe and high. From what has been said it may be gathered that dangerous conditions for kite flying, apart from those that extend down to the ground, are exceptional; and that in the large percentage of cases, when ground conditions permit, a flight may be started with all assurance of safe return of the kites.

Break-aways may be divided into two classes—(a) accidental, and (b) those caused by overloading the capacity of the wire. The former may be largely prevented by attention to the condition of the wire, while the latter may be subdivided into a number of causes as follows:

1. Kites floating on top of a shallow wind, or flying at a low angle, and finally rising into strong wind aloft.
2. Wind increasing rapidly soon after beginning reeling in.
3. Too long exposure of kites to damp, fast-moving clouds.
4. In rare cases, kites being caught in a thunderstorm or sudden squall.

To these may be added the occasional risk of kites falling on account of accumulations of ice, and the unsteady effects of light winds or convection currents.

The prevention of trouble from all of these causes will, to a large extent, be under the control of the field force. Cause 2 will call for the greatest caution on the part of the observer in charge of the flight, but danger from this cause will generally be limited to those conditions remarked under low pressure, and probably in only exceptional cases then. An additional remark in this connection, based on but a few observations, is to the effect that there is some indication that a condition of rising winds, such as might be expected with the approach of a strong LOW is heralded by a high wind at some low or intermediate altitude within the usual range of kites, that subsequently spread vertically in both directions.

[5]M. W. R. Supplement No. 10 (Aerology No. 5), p. 5.
[6]M. W. R. Supplement No. 10 (Aerology No. 5), pp. 5-6.
[7]See M. W. R. Supplement No. 8 (Aerology No. 4), p. 7.

Removing Temper from Hardened Steel

The Swiss journal, *Die Elektroindustrie*, gives particulars of a process for removing the temper from hardened steel. The piece to be softened is placed on a plate of iron at red heat and covered by a plate of cold iron. After the whole has cooled the piece of steel, whatever was its previous quality and degree of hardness, is distempered completely, and can easily be worked without its quality having undergone any change by, for example, decarburization. The method is specially applicable to the unhardening of tools, more particularly punches and dies. Tests have given excellent results, and the method has the advantage that shaped pieces of steel do not show any shrinkage after treatment.

Production of Metallic Coatings

A number of articles to be coated with metal are placed in a rotary container so that they fall freely while exposed to the metallic vapor and particles from a spraying device. Openings are provided in the container for the removal of the excess of atomised metal. The spraying device is fixed at an angle at one end of the container and delivers the atomised metal the whole length of the container. A sand-blasting device may also be fitted to the apparatus. The article to be sprayed with atomised metal is moved mechanically in such a manner that it is coated uniformly, or the sprayed material may be caused to rotate around the article. If the material to be coated is in form of strips or wires, it is moved by suitable means through a closed rotating vessel, in which it is sprayed, the thickness and density of the coating being regulated by the time the material remains in contact with the metal spray and by the temperature inside the container; the wire or strip may also be passed between pressing devices. Several articles arranged parallel to each other may be moved and coated simultaneously; if desired the wires may be rotated at the same time as they are being coated and are passing longitudinally through the container.—*Note in J. Soc. Chem. Ind. on a recent German Patent.*

SCIENTIFIC AMERICAN SUPPLEMENT

Founded 1876

Published by Scientific American Publishing Co.
New York, Saturday, February 15, 1919

Munn & Co., 233 Broadway, New York

Charles Allen Munn, President; Orson D. Munn, Treasurer
Allan C. Hoffman, Secretary, all at 233 Broadway

The Scientific American Publications

Scientific American Supplement (established 1876) per year $5.00
Scientific American (established 1845) 5.00
The combined subscription rates and rates to foreign countries including Canada, will be furnished upon application.
Remit by postal or express money order, bank draft or check

Scientific American Publishing Co.
233 Broadway, New York

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